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Perceived benefits & challenges of biogas adoption among households in Kenya

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List of abbreviations

CBA	Cost-benefit analysis
FGD	A focus group discussion
KIHBS	Kenyan Integrated Household Budget Survey
Ksh	Kenyan Shilling, the currency of Kenya (EUR 1 ≈ Ksh100)
LPG	Liquefied petroleum gas.
PBP	Pay back period (profitability indicator)
UI	A user interview

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Summary

Considering the current cooking fuel energy mix in Sub-Saharan Africa, domestic biogas adoption offers many benefits to local households. This study focuses on biogas adoption in Kenya, where the potential for biogas is hundred times higher than the number of current installations despite decades of promotion since the 1980s. The study contributes to the body of knowledge on biogas adoption by exploring the household perceptions of biogas benefits and challenges in an attempt to elicit the underlying rationales influencing their adoption decisions. The methods employed comprise semi-structured focus group discussions with non-users, and interviews with users.

The findings comprise descriptions of the perceived attributes of biogas use, and rationales for the main challenges of biogas adoption. There is found to be a preference for biogas, considering its attributes of use. However, the financial effects of biogas adoption are shown not to be well understood among households. Consequently, it is argued that the label of biogas as an expensive fuel may dilute the interest and effort of potential users to consider it seriously. Furthermore, lack of information was also clearly stated as a challenge, even in the locations where biogas users lived. An unexpected issue of lack of interest to explore the option of biogas emerged in the fieldwork discussions. Moreover, it was found that the perceived inability to save and the unwillingness to take credit were the other challenges preventing households from biogas adoption. An alternative biogas acquisition model on the principle “pay for use” was discussed with respondents and generated a very positive feedback. Stemming from all the findings, recommendations for biogas promotion are provided.

1 Introduction

Biogas energy for households can be a way to lessen environmental, health and energy problems in countries of Sub-Saharan Africa. Deforestation is one of pressing issues in Africa threatening the societies with its associated negative affects on the ecosystems, agriculture, and, consequently, the economies. However, growing African populations still heavily rely on firewood as the main household energy source, accounting for over 80% of household energy consumption (IEA, 2010). In addition, the widespread use of biomass fuels causes indoor pollution, which ranks among the top five most lethal factors in the developing countries (WHO, 2005). Evidently, a change in cooking fuels is needed to deal with these problems. Moreover, with respect to the global and local risks of climate change impacts and the available potential for renewable energy, a change towards a greener energy mix should be pursued.

1.1 Cooking fuels in Kenya

This study focuses on biogas as an energy source for cooking for households in Kenya. Cooking is the most energy intensive activity for households in developing countries (Murphy, 2001) and the current cooking energy mix in Kenya is not sustainable in many aspects. Firewood is still the most important source of cooking energy, accounting for 68% of household energy consumption, while in the rural areas this share is as high as 88% (Kenyan Integrated Household Budget Survey (KIHBS) 2005/06, cited in Gichohi, 2009). The other cooking fuels used are charcoal and kerosene (see Figure 1).

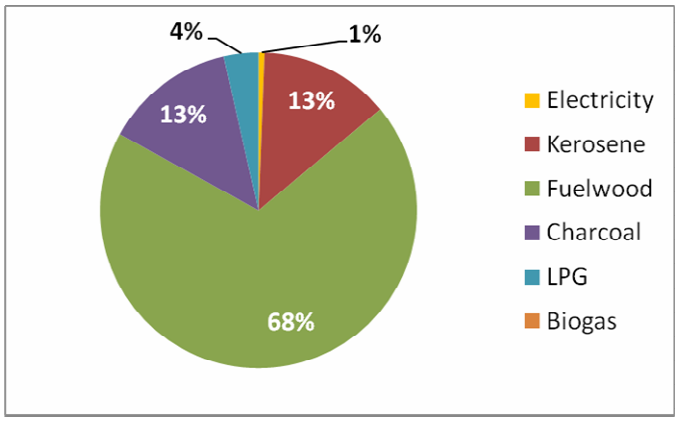

Figure 1. Household energy sources for cooking in Kenya.
Source: KIHBS 2005/06 cited at Gichohi (2009).

The widespread household reliance on firewood and charcoal contributes to the pressures for deforestation. Collecting firewood is a time-consuming activity resulting in opportunity costs and hard work for women. Moreover, all three most used cooking fuels, accounting for 95% of total cooking energy consumption, cause indoor pollution, which means that most of the households currently live under the conditions harmful to health. Lastly, from a global perspective, the use of current cooking fuels produces greenhouse gas emissions and thus contributes to global warming.

A switch to biogas use[1] at a household level may be advantageous with respect to all of the above mentioned issues. Moreover, biogas adoption offers monetary incentives to reduce household

[1] A domestic biogas installation comprises an underground-placed biogas digester, which is fed with the dung of (diary) cattle and water or cattle urine (other organic waste can also be used). Anaerobic digestion process takes place and produces methane-rich gas that is similar to the natural gas and can be used for cooking, lighting or as a fuel for an engine or an electricity generator (ISAT, 2009).

spending on cooking energy. The savings from forgone spending on other cooking fuels in many cases exceed biogas installation costs over time (Gichohi, 2009). This should be an important criterion for cooking fuel choice since a household's spending on cooking fuels may range between Ksh 14,000-80,000 annually (Gichohi, 2009), which takes up a significant share of an average household income[2]. Consequently, alleviating such expenditure through biogas adoption can significantly improve a household's livelihood.

1.2 Biogas adoption gap

From the technical feasibility side, there is a high potential for domestic biogas in Kenya since local climate conditions are favourable[3] and necessary inputs are available to many households: 64% of Kenyan households rear cattle (KIHBS 2005/06 cited in Gichohi, 2009), and minimum 35 out of 71 districts in Kenya are evaluated to have the technical potential for biogas (ETC Group, 2007). The estimates of biogas potential vary greatly due to lack of country-wide data and different underlying assumptions. The available estimates of technical biogas potential range between 500 -1,200 thousand digesters (Biogas for better life, 2007; Gichohi, 2009). Further considering only the households with stable income to access funds and, the estimates of market potential fall to 170-240 thousand biogas digesters (ETC Group, 2007; Gichohi, 2009).

Recognizing its potential, biogas technology has been actively promoted in Kenya since the early 1980s. Nevertheless, its diffusion has not picked up and the actual number of registered biogas installations is around 1400 digesters (Gichohi, 2009), which still is hundred times lower than the most prudent estimate of biogas potential (see Figure 2).

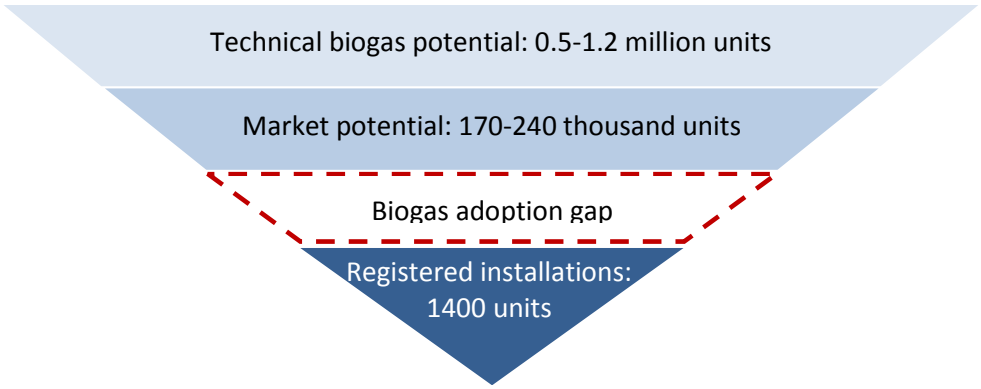

Figure 2. Biogas adoption gap in Kenya.

The reasons underlying the biogas adoption gap observed in Kenya and hampering biogas dissemination in other developing countries are addressed by many studies. These studies could be roughly grouped by their focus on supply and demand related issues (see Section 2 for the detailed literature review).

[2] Gichohi (2009) estimated the average household expenses on cooking fuels in 22 districts of Kenya to be in the range of Ksh 14,000-80,000. Meanwhile, another survey (Mwigiri, 2009) reports the same household expenses to be of around Ksh 50,000 annually.
The estimates of spending can only be compared to indicators of household income since the actual data were not possible to obtain. In 2008 gross national income per capita was Ksh 55,000 (KNBS, 2009) while a household on average had 5.6 members and only 5% of population officially employed (KIHBS 2005/06 cited in Gichohi, 2009). The majority of respondents of this study indicated having household income below Ksh 200,000 per year.

[3] Ambient temperatures in Kenya have little daily and seasonal fluctuations, and this allows using biogas digesters without additional heating. The higher ambient temperatures are the more productive is biogas digester (ISAT, 2009).

From the supply perspective, the issues addressed comprise: lack of capacity of biogas supply sector to meet the technical potential and promote the technology; regulation and accreditation issues for quality control and ensuring contractor competence; also technical issues of sustainable technology exploitation, maintenance and reasons for failures (see ETC Group, 2007; Ni & Nyns, 1996; Parawira, 2009; Quadir, Mathur, & Kandpal, 1995).

From the demand side, most of the previous research relied on household surveys to elicit the socio-economic differences between biogas users and non-users or to extract the stated reasons for biogas non-adoption (see Mwakaje, 2008; Mwigiri, Makenzi, & Ochola, 2009; Walekhwa, Mugisha, & Drake, 2009). Consequently, the main biogas adoption barriers identified correspond to a household's lack of abilities to adopt biogas with respect to differences in socio-economic characteristics between biogas users and non-users. The stated reasons for biogas non-adoption, likewise, refer a household's inabilities to adopt biogas, mostly due to lack of information about the technology and financial problems to obtain the needed funds. However, a household's preference for biogas is often assumed to be present in the set-up of the studies, and the underlying factors driving or suppressing the preference for biogas are not addressed. Also household perceptions of biogas adoption challenges are not thoroughly explored, which provides a niche to fill in.

1.3 Focus of the study

Biogas adoption decision, as any adoption decision, cannot escape the behavioural aspects and individual perceptions of product attributes (Adesina & Baidu-Forson, 1995; Wilson & Dowlatabadi, 2007). This paper contributes to the body of knowledge on biogas adoption by exploring household perceptions of biogas as a cooking fuel and their possible effects on the decision to adopt the technology. Therefore, the overarching research question is:

> *What are the perceived benefits and challenges influencing household decisions on biogas adoption in Kenya?*

In this study the term "adoption" is defined as a household's decision to acquire and rely on using a certain technology, in this case biogas. The adoption decision is analyzed in two stages, corresponding to two research sub-questions:

1. What are the perceived attributes of biogas use influencing the preference for biogas? Is there a recognized preference for biogas?
2. If there is a recognized preference for biogas, what are the perceived challenges preventing households from biogas adoption?

To answer the first question, positive and negative aspects of biogas use were explored and compared in order to picture the strength of the preference. Meanwhile, the second question focuses on the perceptions of challenges of biogas adoption, which are related to household abilities to adopt biogas, if there is already a recognized preference.

With respect to the exploratory nature of the research questions, qualitative research tools were employed. The key informants of the study were households without biogas, but having a technical potential to adopt it (hereinafter, non-users). In addition, nine interviews with biogas users were conducted, and the obtained information was used as comparative material. The product of this study is a structured narrative based on non-user perceptions and an analysis of their possible implications on the biogas adoption gap.

This study provides useful information for the business actors and other institutions related to biogas promotion, especially, but not limited to Kenya. The outlined rationales of potential users indicate what aspects of biogas adoption should be addressed and how biogas promotion could be facilitated. Biogas also shares some similarities with other renewable energy sources in terms of

the cost structure and its environmental benefits. Therefore, the insights of this research could be relevant to the adoption studies of other renewable energy technologies for households.

The paper is organized as follows. Section 2 provides the literature review on biogas benefits and challenges. The research methods, content and design of the fieldwork are described in Section 3. Section 4 presents the results of this study divided according to the research sub-questions: the first part elaborates on the perceived attributes of biogas use, while the second part focuses on the challenges to biogas adoption given the recognized preference for its use. Section 5 provides the discussion of the results. Lastly, conclusions and recommendations are presented in Section 6.

2 Literature Review

The literature review describes previous research on biogas adoption focusing on the issues that could influence households' perceptions of biogas adoption. The findings are split into benefits and challenges.

2.1 Literature on biogas benefits

Although biogas is praised in the literature for its many benefits, it is important to consider which of the benefits accrue directly to the household using biogas and which profit the society at some level, since it has different effects on a household's adoption decision (Ni & Nyns, 1996). Below biogas benefits are presented according to their recipients.

First and foremost, biogas adoption can bring multiple private benefits to households. Since biogas is a substitute for other cooking fuels; it reduces household spending on cooking energy. Previous research shows that households use a mix of fuels rather than rely on one fuel for cooking, therefore, the use of biogas rarely substitutes other cooking fuels completely: the substitution rate is found to be 50-80% (Gichohi, 2009; Mwigiri et al., 2009). With 80% substitution, the incurred savings are proven to outweigh the installation costs within a period of up to ten years in many Kenyan districts[4] (Gichohi, 2009). Furthermore, switching from traditional cooking fuels, like firewood, reduces the workload for women and children, who are typically involved in firewood collection (Brown, 2006; Mwakaje, 2008). The time savings on firewood collection amount up to 50-90 hours per month, which could be used to engage in other economic activities (Jain, 2010; Mwakaje, 2008). Moreover, biogas is a clean cooking fuel since it produces no smoke; therefore, it reduces indoor pollution and the associated risks of respiratory and eye problems. Pant (2007) shows that firewood would be the most expensive cooking fuel in Nepal if its health costs would be accounted for. In his study it also calculated that the savings solely on the foregone health costs can outweigh all biogas installation costs over a plant's lifetime. Biogas use may also improve sanitation through contained cattle manure management, which otherwise poses a risk of spreading parasitic diseases (Brown, 2006; Karakezi, 2002; Remais, Chen, & Seto, 2009). In addition, biogas side product is bio-fertilizer, which can substitute the chemical fertilizer or cattle manure. It could induce more savings on chemical fertilizer and increase harvest yields due to the higher effectiveness of the effluent since it contains all the nutrients in a more accessible form for plants' uptake (Akinbami, Ilori, Oyebisi, Akinwumi, & Adeoti, 2001; Brown, 2006). All in all, findings exist that biogas can improve the financial situation of many households considering only cooking fuel expenditure; however, if all other benefits are evaluated, the effect of biogas is even more advantageous.

On the other hand, biogas yields some important external benefits that serve society rather than a user's household. However, they may also be considered by a household to some extent as it benefits one's community. Most importantly, biogas is a sustainable solution to provide energy. Biogas use is reducing household demand for firewood, thus it contributes to mitigating deforestation. In South-West China, one household using biogas instead of firewood (which accounts for 60% of household energy consumption, similarly to Kenyan households) for a year can save around 3 tons of firewood, which is comparable to one acre of forest (Jian, 2009). Furthermore, from a global perspective, biogas is a carbon neutral source of energy, thus

[4] The net present values of biogas projects were calculated in 15 districts of Kenya based on household spending on other cooking fuels, and average biogas installation and maintenance costs. A discount rate of 12% was applied, which accounts for the cost of credit financed through a cooperative (Gichohi, 2009).

contributes to lowering carbon emissions though traditional fuel substitution and preventing methane escaping into the atmosphere [5] (Yu, Yaoqiu, Ningsheng, Zhifeng, & Lianzhong, 2008).

2.2 Literature on challenges of biogas adoption

Despite the multifaceted benefits, biogas adoption is not picking up in Sub-Saharan Africa, including Kenya (Gichohi, 2009; Parawira, 2009; Walekhwa et al., 2009). The literature on biogas adoption points out different challenges examining the issue from different perspectives.

A group of studies looks at the biogas adoption gap from a market perspective addressing mainly supply related issues. First, the capacity of biogas supply is insufficient to promote the technology to meet its potential: there are too few active technicians in Kenya, and the promotional activity is scarce (ETC Group, 2007). Furthermore, the sector in Kenya and other developing countries is not regulated at a national level: the accreditation of suppliers is not centralized; there is a lack of installation standards and quality control, which leads to inadequate competence and service of suppliers (ETC Group, 2007; Parawira, 2009). Consequently, the lack of competence and experience among biogas contractors increases the incidence of poor quality plants being built and leads to higher failure rates (Parawira, 2009; Quadir et al., 1995). The failure rates are further increased due to the lack of post-installation support, poor user access to maintenance services, as well as lack of responsibility and proper management among users (Parawira, 2009; Quadir et al., 1995).

The impact of the supply and technical issues on household's perceptions is noted in a few studies. Some potential users may be deterred by the negative image arising from biogas failure incidents (Mwigiri et al., 2009) and difficulties to obtain technical support (ETC group, 2007; Jian, 2009; Mwakaje, 2008). The perceived technical requirements for additional labour may also be deterring (Jian, 2009). Acceptability of use of dung to produce cooking gas, are cited as a challenges in certain societies (Quadir et al., 1995), however, this issue is not pronounced in the studies of potential biogas users in Kenya (ETC Group, 2007; Mwigiri et al., 2009).

Another group of studies analyzes the issue of biogas adoption at the micro level to elicit the reasons for biogas adoption as stated by households, the demand side. There are two most pronounced challenges in these studies: financial and information issues. According to a household survey in one district of Kenya, the lack of knowledge about biogas technology is the main reason for non-adoption indicated by 44% of the respondents, while lack of money is pointed out by another 32% of the respondents (Mwigiri et al., 2009). Another qualitative study in Kenya also highlights the affordability issue along with hesitance to take a credit, and lack of awareness among potential users (ETC Group, 2007). A household study in Tanzania portrays the un-affordability of biogas as the main obstacle to adoption, stated by 75% of respondents, while the information barrier is reported to be negligible (Mwakaje, 2008). In addition, a case study in a village of China shows that the financial pay-off of biogas adoption may not be perceived, while confirming the pronounced barriers of high up-front costs and lack of knowledge about the technology (Jian, 2009).

Finally, there are studies addressing the issue by examining the socio-economic differences between biogas users and non-users. It is found that Kenyan households with higher education of household head, higher household income, larger farm sizes, more cattle possessed, especially if zero grazing is used, are more likely to be biogas users in Kenya (Mwigiri et al., 2009). Walekhwa et al. (2009) confirms that a higher income and more cattle owned lead to biogas

[5] A domestic biogas digester of $10m^3$ can save up to 1.5 t CO_2 per year, using coal combustion for the same amount of energy as a baseline. In addition, biogas use prevents a large portion of methane, which is over 20 times more powerful greenhouse gas than CO2, produced by cattle rearing, from escaping into the atmosphere. However, the precise estimations of this particular biogas impact are difficult to make. (Yu et al., 2008)

adoption in Uganda. In his study several other attributes are found to have a significant impact on biogas adoption as well: younger household heads, as they maybe more risk taking to try novel technologies; larger household sizes, since there are more people to share the additional labour, and higher costs of alternative fuels, which increases the savings from biogas. Interestingly, the same study has found education to be negatively correlated with biogas adoption once the respondents have obtained post-secondary education. Accordingly, higher educated people opt for administrative and management positions and tend to live in urban settings, while biogas is depicted as an energy source for the rural people.

In principle, the differences of socio-economic factors echo some of the stated reasons for biogas non-adoption. First, the stated lack of money is consistent with findings that biogas users have better access to funds due to their higher income, which should correlated with more cattle and larger farm sizes. Moreover, the stated challenge of lack of information is consistent with the findings that the younger and sufficiently educated household heads are more likely to adopt biogas, since they may have the skills to acquire information.

The presented literature findings are summarized in the Table 1.

Benefits of Biogas Adoption	
Private benefits	- Monetary savings on cooking fuels - Time savings and reduced workload for women - Reduced indoor pollution - Improved sanitation - Bio-fertilizer
External benefits	- Reduced deforestation pressures - Lower greenhouse gas emissions
Challenges of Biogas adoption	
Supply related issues	- Lack of supply capacity - Incompetence of contractors - Lack of centralized supplier accreditation - High biogas failure rate - Lack of post-installation support and maintenance services - Improper management by users
Stated reasons for biogas non-adoption	- Lack of knowledge/ information; - Lack of money - Hesitance to take credit - Unperceived pay-off effects - Additional labour
Technology related demand deterrents	- Negative image of biogas failure incidents - Unmet user expectations on biogas output - Lack of access to technical support
Socio-economic characteristics of biogas users compared to non-users	- Higher income - Larger farm sizes - More cattle - Zero grazing of cattle - Larger households - Higher (sufficient) education of household heads - Younger household heads - Higher cost of other fuels

Table 1. Summary of the literature findings on biogas benefits and challenges to adoption.

3 Methodology

This chapter introduces the reader to the research methods used. First, the advantages and limitations of qualitative research are outlined. Second, the contents of the fieldwork interactions are presented. Third, the fieldwork design is explained. And lastly, the actual fieldwork process is described along with the limitations encountered.

3.1 Research methods

This study was based on two semi-structured methods of qualitative nature: focus groups discussions [6] (hereinafter, FGDs) with non-users and interviews with biogas users. Qualitative data from FGDs with non-users was the main source of information for answering the research questions posed; therefore, the fieldwork design was centred on the FGD settings. Meanwhile, the information obtained from the user interviews was used to compare their experiences with the non-user views on the same issues.

The reasons for choosing a qualitative research approach stem from an intention to discover new insights to explain the biogas adoption gap in Kenya from a household point of view. As outlined in the literature review, the previous studies address the demand issues of the biogas adoption by employing mostly quantitative methods. This study is different and complementary in its approach. The methods used are exploratory in nature with an aim to reveal the variety of possible underlying rationales of Kenyan households that affect their decision on biogas adoption. The questions employed can be general and findings comprise both, what respondents have said and what was not said at all.

Qualitative research has no *ex-ante* assumptions that could limit the variety of possible answers; instead the exploratory approach is helpful and needed to shield new insights on the observed phenomenon. Also qualitative research is effective to capture the variety of explanations on the issue while maintaining a feasible number of interactions under given time or budget constrains. Moreover, FGD as a tool is very commonly applied in customer research as it allows explaining observed customer behaviours better (Maynard-Tucker, 2000).

However, the results of qualitative research should be interpreted carefully for not to make incorrect conclusions. Notably, qualitative research cannot reveal a prevailing cause-effect relationship that could be projected to the majority of cases: it does not differentiate between more and less dominant views. However, its aim and ability is to extract the variety of possible explanations for the meanings behind the observed behaviour trends, like possible explanations of household rationales related to biogas adoption. Consequently, the output of this study should be read as a picture of possible ways to perceive the option to adopt biogas in the minds of Kenyan households. Quantitative studies should be conducted to test the qualitative insights on a representative sample in order to measure their relevance to the majority of population.

3.2 Content framework

Since the research question of this study is exploratory and not addressed to specific issues of biogas adoption, the interactions with respondents contained both: general questions to identify the issues related to biogas adoption and probes for specific issues, which were based on the

[6] Focus group discussion is “a group situation in which the participants talk with one another under the guidance of a moderator for the purpose of generating relevant ideas and information.” (Kumar ,1987, p. 4)

findings of previous research. The guidelines for FGD facilitator and the questionnaire for a user interview can be found in Annex A and Annex C, respectively.

Both questionnaires, for user interviews and for FGDs, covered the following topics:

1. Technology & Information sources
2. Benefits of biogas use
3. Challenges of biogas adoption and use
4. Financial effects of biogas use
5. Funds for biogas adoption
6. Alternative biogas acquisition model: “Gas for cash”

The discussions started with neutral questions about biogas technology and information, to encourage the group to share and refresh their knowledge on biogas working principles and possible information sources. In the discussions on biogas benefits, all the benefits presented in the literature review were discussed by respondents’ or our initiative. Discussing the challenges of biogas adoption and use, likewise, the respondents were first confronted with general questions and then a checklist was used to address specific issues. The issue of funds was assessed separately; while the lack of information was not addressed specifically as the fieldwork was designed to go around this issue (see Section 3.3). Special attention was given to the financial effects of biogas and its comparison to other fuels, since literature indicates that biogas pay-off may not be recognized (Jian, 2009). Finally, an alternative biogas acquisition option was presented for feedback: the “gas for cash” model, which is described along with the results (see Section 4.2.2). The issues emerged during the discussions were later grouped according to their relevance to the research sub-questions.

The same list of topics for discussion was maintained in all fieldwork activities. It was instrumental for comparing the answers of different respondent groups and observing to what extent their characteristics may imply differences in perceptions of biogas adoption.

3.3 Fieldwork design

The following sections describe the design of the fieldwork activities and reasons for the choices made.

3.3.1 Differentiation of fieldwork settings

Since the focus of this study was on the output of the FGDs with non-users, the fieldwork was designed in order to organize a number of focus groups with different settings that could add to the variety of results. According to the FGD methodology (Krueger & Casey, 2000), if different respondent characteristics can add new insights on an issue, separate FGDs have to be organized for each respondent group, while striving to ensure homogeneity within a group. Homogeneity within a focus group facilitates the analysis because the obtained respondents’ opinions can be clearly attributed to their particular characteristics.

The following criteria were considered when designing the FGD sampling strategy:

1. **Peri-urban vs. interior area.** A peri-urban area is defined as being geographically close to an urban center, exhibiting high population density and having many people who earn a share of their income through wages, likely in the urban centre. Interior area comprises rural villages and small towns situated far from the urban centers, with lower population density and higher reliance on subsistence farming. The level of urbanization is relevant to biogas perception as it represents different user groups in terms of their living standards and contexts (Sahn, & Stifel, 2003), which determines different priorities for spending, income sources and risks, therefore, different accessibility to credit (Gichohi,

2009). Moreover, the cooking fuel mix is also very different in urban and rural areas (see Figure 3). A prerequisite for our area choice was a sufficient technical potential for biogas, in terms of availability of cattle and water. A preference was given to areas with high market potential in terms of short payback period on the investment into biogas. In this case the fieldwork results could be attributed to highly potential users, whose reasons for biogas non-adoption are of a particular interest.

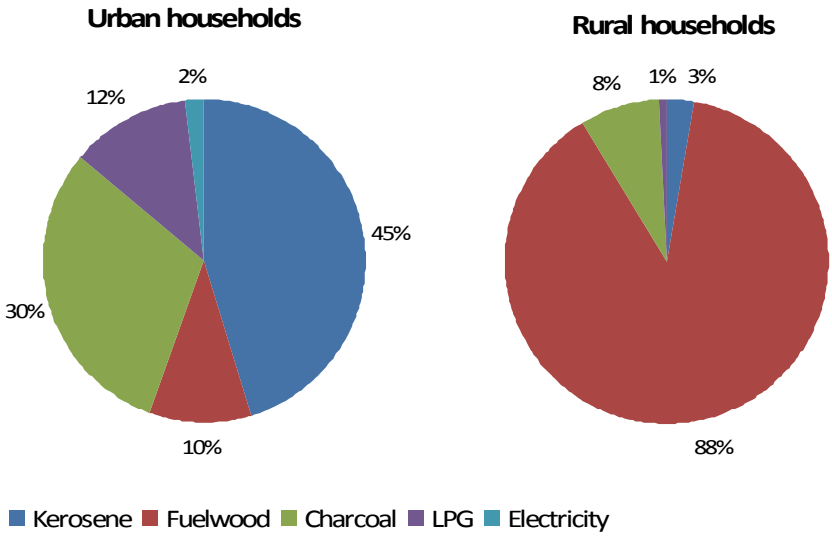

Figure 3. Household energy sources for cooking in urban and rural areas of Kenya. Source: KIHBS 2005/06 cited at Gichohi, 2009.

2. **Locations with and without biogas users.** Lack of awareness is sited as one of the main reasons for low biogas adoption in Kenya (see Section 2.2). Therefore, it was expected that the respondents who live in the neighbourhood of a biogas user would elicit different reasons for biogas non-adoption, other than the lack of information. In addition, comparing the latter respondents' views with those of the respondents living in locations without biogas was expected to show what discrepancies of information, if any, emerge due to different of exposure to the technology. In each area, it was decided to conduct FGDs in two locations with biogas users in order to have more informed respondents, and in one location with no biogas around for comparison.

3. **Female vs. male participants.** Different genders of participants relate to different roles in the use of cooking fuels. Most of the work related to cooking fuel preparation and cooking is done by women (Brown, 2006), while financial affects concern the entire household. Therefore, perceptions of biogas could be different among men and women. In addition, FGD guidelines often advice to conduct FGDs with participants of the same gender (Krueger, & Casey, 2000). Consequently, in each location two focus groups were conducted with female and male participants being interviewed separately.

User interviews were to be conducted in the same locations where FGDs were organized or in the locations nearby. Actually, the FGD locations with biogas users were to be chosen according to the locations of biogas users participating in our research. If a location was known to have biogas users, there had to be at least one user agreeing to be interviewed, to organize FGDs there. User interviewees were not differentiated by any of the criteria used for FGDs, but there were certain conditions applied for their selection (see Section 3.3.2).

In total, there were 12 FGDs and 9 user interviews conducted in two areas and six locations for the FGDs and two additional locations nearby for extra user interviews. The overall layout of the fieldwork is presented in Figure 4.

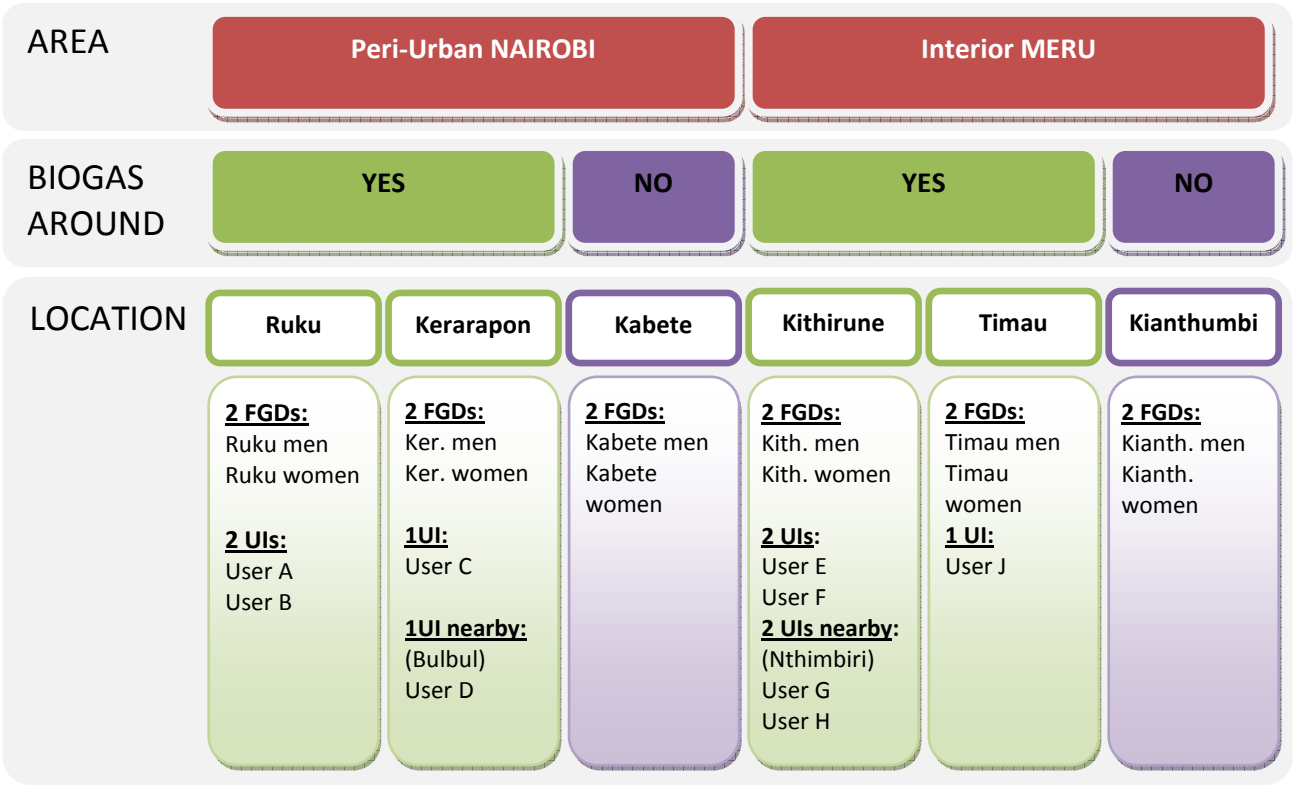

Figure 4. Fieldwork design.

3.3.2 Respondent selection criteria

There were a few criteria applied for the selection of participants irrespective to the different fieldwork settings.

All FGD participants were interviewed prior to an FGD event to fill a short questionnaire on their personal and household information (see Annex B). The following criteria were decisive for the selection of FGD participants:

1. Influence to household decision making: the target participants were household members who make decisions on the cooking fuels used in their household, namely, a household head or a wife to a household head.
2. Awareness of biogas technology: It was crucial for the recruited participants to be familiar with the basics of biogas technology; otherwise, they would not contribute to the discussion. Therefore, everyone was asked if she or he knows about biogas as a cooking fuel.
3. Technical potential: it was aimed to recruit participants from the households which had a sufficient technical potential to adopt biogas: minimum 2 dairy cattle, preferably kept under zero or mixed grazing, though free range was also allowed because grazing type can be changed.

The level of household income is also important for both biogas adoption and group homogeneity. However, it was hard to obtain such information before recruitment and socially inappropriate to refuse a participant based on this information after approaching. Therefore, such information was gathered but not used as a selection criterion. Other information about FGD participants was gathered to be used as background information.

In addition, there were a few criteria used for the selection of biogas users to be interviewed:

1. The main criterion was that the biogas installation is used only for their household's consumption, excluding the installations used for commercial or institutional activities, like hotels or schools.
2. The targeted interviewees were a household head or a wife to a household head, the actual decision makers.
3. The users who had a biogas digester in use for at least 6-24 months were preferred because in such cases they would have sufficient use experience, while still recalling their decision to adopt a biogas digester and the reasons for it.

3.4 Fieldwork process and limitations

The entire fieldwork took place in May, 2010, lasting for the period of three consecutive weeks. FGDs and user interviews were organized simultaneously and conducted interchangeably, without a predefined order. The following sections describe the actual process of the fieldwork and limitations encountered (see Table 3 for the summary of limitations).

3.4.1 Choice of areas

It was chosen to research two areas, namely peri-urban locations around Nairobi (hereinafter, peri-urban Nairobi) and interior locations in the Central Meru district (hereinafter, interior Meru; see Annex E for the maps). The researched locations of peri-urban Nairobi belong to different districts; namely, Kiambu and Kaijado. However, since Kaijado district is very large and expands in to the interior, Kiambu district data was taken to be representative of all the locations in peri-urban Nairobi.

The areas were selected based on the estimations of biogas market potential provided by Gichohi (2009, see Footnote 4). Both Meru central district and Kiambu ranked as the second and the forth, respectively, among the most potential districts in the sample. In both districts the estimated payback period for a biogas plants amounted to 3-4 years.

District	Payback period for biogas plant (years)	Population density, people/km2	% of households with wage income	% of households that sort credit	% of population below national poverty line	% of literate population
Kiambu	4	660	63.6	27.7	25	94.8
Meru Central	3	175	10.0	15.2	41	81.3

Table 2. Population differences in areas researched.
Source: Gichohi, 2009.

The two selected areas are very different in their level of urbanization, Nairobi being the largest urban center in East Africa. Consequently, their differences comprise: population density, share of people earning their income through wages, use of credit, and literacy rates (see Table 2).

3.4.2 Selection of locations

In each area, the aim was to find two locations with minimum one biogas user in the neighbourhood and one location where there is no biogas. Therefore, the choice of fieldwork locations with biogas was restricted by the available contacts of biogas users. We also needed some guidance to find locations where it was known that there was no biogas, while households

had cattle and preferably used zero-grazing units. Obtaining that kind of information was facilitated by the Association of Biogas Contractors of Kenya for the fieldwork in peri-urban Nairobi and a locally active NGO, the Netherlands Development Organization (also known as SNV) for the fieldwork in interior Meru. Also, in peri-urban Nairobi, the research team was able to use snowballing technique to obtain additional contacts of biogas users from the users interviewed. However, in interior Meru this turned out to be impossible because the users contacted could not provide us with contacts other than we already had.

There are several limitations arising from the described process of selecting locations.

1. In Meru area we had to rely on a single contractor for the contacts of biogas users. In result, all the biogas users visited were clients to the same contractor. This could have biased our results to be more positive about biogas because the contractor was likely to give us his most successful cases.
2. The choice of fieldwork locations was constrained by time limitations and the ability of the information providers to supply us with user contacts in the locations according to the fieldwork design. It was a struggle to find biogas users as close to the urban center as possible in the fieldwork in peri-urban Nairobi; and likewise, much effort was dedicated to obtain the contacts of users as far as possible in the interior around Meru town. Since we were usually given verbal directions to user locations we could not know where we would end up before actually driving there; therefore, sometimes we had to proceed with the fieldwork due to no time to find a better location. The limitations most of all effected the fieldwork in the interior Meru, as the goal was to travel deep into the interior, but the verbal explanations and stated distances did not reflect the actual proximity to Meru town, and we ended up in locations within 20 kilometres from the town. For the same reasons, our locations without biogas turned out to be within 5 km distance to a known biogas installation, though initially the distance was aimed to be bigger.

3.4.3 Recruitment of participants

Most FGDs were conducted with a group of 6-8 participants, which is cited as an ideal group size in the literature (Krueger & Casey, 2000). However, a few groups had more participants because we used to over-recruit in order to compensate for participants' no-shows or being up to one hour late.

Due to time constrains the FGD groups were usually organized by a person from the same location, who was willing to take upon this task and was not a biogas user. The person was informed about the criteria for participant selection and asked to invite people in the neighbourhood, only one person from the same household. This approach turned out to be more time efficient than recruiting participants by ourselves, since people agreed easier to participate when invited by someone they know. The participants were interviewed by the research team before an FGD starts.

This has posed some difficulties for proper selection as the author was not able to oversee the information of all participants before the FGD starts. In result, we had a few cases when a daughter or son to a household head was participating or a person with no cows was in the discussion. However, in the majority of cases the selection criteria were met and no focus group was dismissed as irrelevant to the analysis.

3.4.4 Characteristics of the fieldwork respondents

Since the sampling for this study was designed with an aim to increase the variety of viewpoints rather than represent a population, the description of the respondents below should be seen as instrumental for analysis purposes. The characteristics of our two respondent groups are provided

in order to account whose viewpoints are presented and analyzed in the results chapter. By no means are these observations inferring any differences between biogas users and non-users, in general.

In total over a hundred respondents participated in this study: there were 95 non-users participating in the FGDs and 9 biogas users interviewed. The characteristics of the respondents are summarized in Annex D.

For the non-users, the main recruitment criteria were fulfilled. All the respondents, with a few exceptions, were either a household head or a wife to a household head. All but one household had at least one cattle and 90% used zero grazing units for their cattle rearing.

Regarding the other characteristics, the majority of FGD participants were of 30-50 years old, the non-users in the interior Meru being on average older than the non-users in the peri-urban Nairobi. The majority of participants had secondary education. The average household size was between 4-5 persons. The average household income per year was stated to be below Ksh 200,000 for the majority of non-users in both areas. Meanwhile, the average spending on cooking fuels was significantly higher among the respondents in peri-urban Nairobi (average of Ksh 25,000) compared to the respondents in interior Meru (average of Ksh 16,000). This was due to more common use of firewood collected for free that was reported in the interior settings. Overall and consistently with the national averages, almost all participants in interior Meru used firewood as their main cooking fuel, while many respondents in peri-urban Nairobi reported using charcoal or gas. About 70% of the non-users in this study knew a biogas user, and half of the respondents had seen a biogas digester.

Looking at the group of the users interviewed, the main differences should be noted for the analysis purposes. First of all, the users reported having a considerably higher annual income, especially in Nairobi (more than Ksh 500,000). Likewise, their reported spending on cooking fuels before biogas adoption was higher than the average spending of non-users. Moreover, the interviewed users had higher than secondary education, and four out of nine were teachers by occupation. Most of the users had some farming for the subsistence needs, including dairy farming; however, many of them also earned part of income through salary or a business activity.

The selection criteria for biogas users were fulfilled as in all the cases the interviewees were household decision makers, using biogas for their private needs only. The use of biogas averaged to 1.5 years; however, one very new user and one early adopter were interviewed as well.

3.4.5 Method of conduct

All FGDs were conducted by the same person, a local research assistant, always following the same FGD facilitator guidelines. The language of conduct was decided to be Swahili in the fieldwork in peri-urban Nairobi and Swahili or the local dialect in the fieldwork in interior Meru. A test FGD was carried out leaving the option for the participants to choose between using English or Swahili languages. In result, the participants who felt more comfortable with speaking English were dominating the discussion, while the others were less active.

User interviews were conducted by the author or the research assistant. The language of conduct in most cases was English and at times Swahili, depending on an interviewee's preference.

All questionnaires were pre-tested once and adjusted according to the observations. The final user questionnaire took up to 1.5 hours to go through; while a typical FGD lasted up to 2 hours, depending on the amount of discussions generated.

In all the events the data was collected by a voice recorder. During user interviews a questionnaire was being filled in the process. During FGDs a note taker was present who made some notes and later transcribed the conversation from the recordings.

The outlined set-up of the fieldwork process resulted in several limitations with respect to the content:

1. The use of Swahili language for FGD conduct made fieldwork results inaccessible for the author until they were transcribed. Due to time constrains all FGDs were conducted in three subsequent weeks, leaving no time for transcribing and adjusting the contents during the fieldwork. As a result, the research could not benefit from follow-up questions to understand the obtained non-user rationales better.
2. Also, FGD participants were very positive about biogas though they have not adopted it so far. Despite our disclaimers on any association with biogas promoters, it was possible that participants had expectations to benefit from the projects subsequent to this research. This may have biased our observations since respondents may have overstated their preference to biogas hoping to benefit from it later.

3.4.6 Data processing

The materials from the fieldwork comprised 12 translated transcripts of FGDs, and 9 transcripts of user interviews. The method of data analysis was similar to the "long table approach" described in methodical literature for FGDs (Krueger & Casey, 2000).

All the transcripts were analysed by grouping respondents' statements by the main topics of discussion, as provided by the conceptual framework (see Section 3.2). Then emerging issues and key arguments were identified within each topic. The outputs on each topic were compared between different respondent groups, highlighting the most frequently observed lines of thought and the argumentation behind. The differences between respondent groups were noted as well, if they were explicit and prevalent. The frequency of certain issues appearing in the discussions was purposively described by adjectives rather than numbers, following the guidelines of interpretation of FGD data: since the sample of focus groups may not be representative of the population, citing numbers and shares of frequency may lead the reader to unintended conclusions (Krueger & Casey, 2000). The comparative analysis benefited a lot from maintaining the same key topics in all the interactions.

Limitations related to	Description
Research method (Section 3.1)	- Qualitative research cannot reveal a prevailing cause-effect relationship that could be projected to the majority of cases: it does not differentiate between more and less dominant views
Selecting Locations (Section 3.4.2)	- User contacts in the interior Meru were provided by a single contractor which might have created a bias on the results dependent on the competency of the contractor. - Limited number of user contacts provided and time constrains led to conduction of the fieldwork in the best locations possible, but not as far in the interior or as distant from biogas users as it was anticipated.
Recruitment of respondents (Section 3.4.3)	- FGD respondents were mostly recruited by local persons based on our instructions. This led to several cases that FGD participants who did not meet the selection criteria, still were participating in the discussions.
Method of conduct (Section 3.4.5)	- The use of Swahili language for FGD conduct made fieldwork results inaccessible for the author in the process of conduct, preventing the use of follow-up questions to obtain more thorough data for the analysis. - The FGD respondents may have overstated their preference for biogas due to possible expectations to benefit from the activities presumably related to this research.

Table 3. Summary of fieldwork limitations.

4 Results

The issues that emerged during the discussions with respondents are grouped into two main parts, according to the research sub-questions. First, the attributes of biogas use are discussed, comprising the benefits of biogas use, financial effects, and the challenges of biogas use. Second, the challenges of biogas adoption are discussed: if biogas is assumed to be a desired option for cooking energy, what are the issues preventing the households to adopt it? Figure 5 presents the layout of the issues presented.

Throughout the discussion the focus is on the perceptions expressed by the non-users during the FGDs. Their perceptions are compared to the reported user experiences and relevant literature findings. In addition, the prevailing differences between different FGD settings are highlighted.

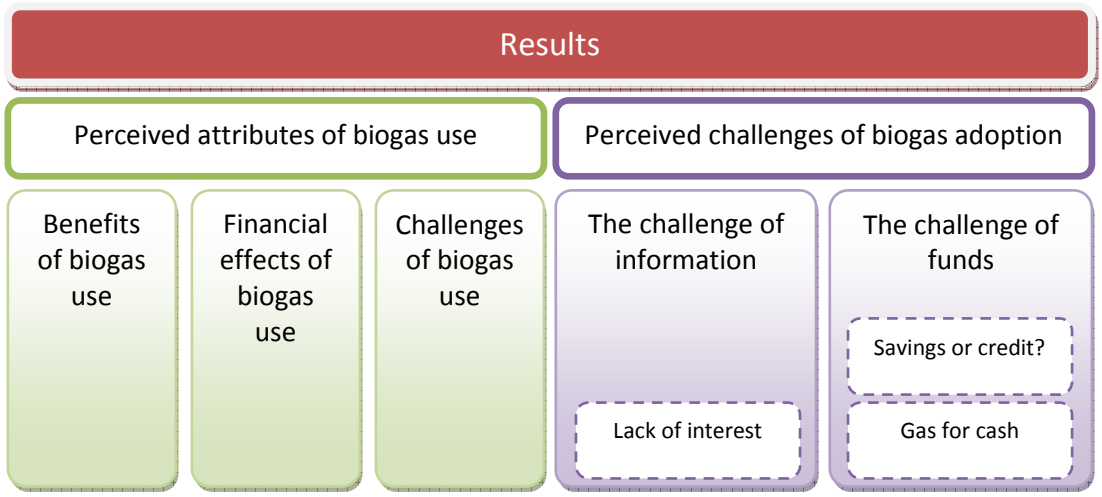

Figure 5. The layout of the topics

4.1 Perceived attributes of biogas use

In the sections below, first, the benefits of biogas use are presented. Second, a separate exercise was devoted to discuss the financial effects of biogas use, and the feedback obtained is described. Third, the challenges related to biogas use are discussed.

4.1.1 Benefits of biogas use

"The pocket will be bigger, one will save!" (FGD: Timau men)

This section describes the perceived benefits of biogas use and depicts the associated respondents' rationales. The benefits are presented by their frequency of appearing in the discussions: first the most pronounced benefits are put forward, and then the other benefits are described (see Figure 6).

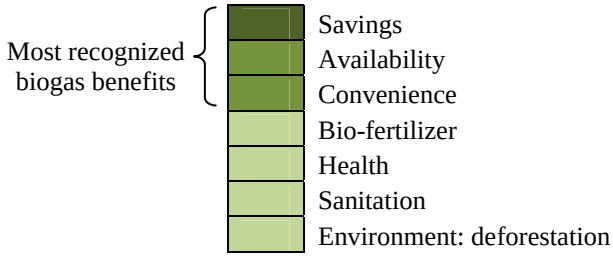

Figure 6. Benefits of biogas use.

Most recognized biogas benefits

This group comprises the topics which were dominant in the FGD participants' answers and were mostly brought up by the respondents without our probes.

First and foremost, biogas is expected to bring **savings** on other cooking fuels. All non-users recognized this benefit without probes, and it was among the first biogas benefits to be mentioned in the FGDs. Additionally, most of the users named it to be their driving reason for biogas adoption decision.

An interesting framing of savings from biogas was that *"it adds more value to your cow"* (User J in Timau), which was also recognized in the FGD with Ruku men:

> *"When we look at this cow dung we normally threw to the farm… and also after using it in the processing with bio-gas, still you will take it to the farm. It adds manure to the farm, but in the process before we take it to the farm… we have to use it before."*

In other words, biogas technology was portrayed as a tool to utilize one's assets in a better way. Typically a cow provides milk and manure, which is used as fertilizer. Moreover, having a biogas installation makes it possible to harvest a cooking fuel from the same cow, without loosing the other benefits.

Monetary savings, and more use of one's assets, both lead to opportunities to improve ones livelihood, which respondents recognized in their own terms:

> *"The money spent on fuels can be channelled to other needs."* (FGD: Kabete women)
> *"I felt, because firewood was one of the biggest expenses, this cost could cover for some other projects e.g. school fees (…) I wanted some money to do other development."* (User F in Kithirune)

Another widely recognized benefit of biogas was **availability**. It is hard to understate its importance in the settings of Sub-Saharan Africa where household access to energy depends on fuel suppliers and changing firewood availability, which could be termed as lack of physical energy security (Jain, 2010).

First, most non-users mentioned the time savings in getting the fuel as the main attribute of better availability of biogas:

> *"She {the mother} will not fetch firewood because on firewood too much time is lost."* (FGD: Kithirune men)

Even if a cooking fuel is purchased, like charcoal or a cylinder of gas, it is cumbersome and takes time as well as costs to bring the fuel from a market, while biogas is readily available at a user's home.

Second, a few non-users pointed to the certainty of access to biogas in contrast to the uncertainties related to firewood scarcity or supply cuts:

> *"It {biogas} is always available like now there is no gas even in the petrol stations, there is shortage."* (FGD: Kabete men)

Likewise, all users acknowledged biogas availability as an important benefit, mostly appreciating their time and effort savings and sometimes referring to increasing firewood scarcity and their secure position regarding it:

> *"Like now the firewood is running out, so with me, you see, I will be at a better position because there is no time the cows are not going to eat, you see? And as they eat they are going to give me cow dung, so there is no time I will be in short of? …biogas. (Very pleased)"* (User D in Nthibiri)

Convenience is another biogas advantage widely recognized both among users and non-users. Though availability could also be related to convenience, here the term conveys the convenience of use rather than getting the fuel (availability). Non-users expect biogas to be convenient mainly in terms of time needed for preparing the fuel for use and cooking a meal with it:

> *"If {before} I was using two hours to cook, now I will spend half an hour"* (FGD: Kerarapon women).

Another advantage of biogas attributed to convenience by many non-users is that the gas does not produce any smoke; therefore, the kitchen is cleaner and the duties for cleaning are less. In some FGDs with women, having no smell while cooking was also appreciated. There was no difference perceived between biogas and LPG in terms of convenience, and both of them were considered to be the most convenient cooking fuels available.

The users interviewed praised biogas for its convenience for the same reasons as listed above, only they were able to depict a more detailed picture of biogas use, e.g. eliciting the comfort of biogas use by examples:

> *"My work becomes easy, I don't struggle to split firewood, collecting from the farm; I meet my gas in the house. (…) Without lighting and lighting the firewood again, adding firewood… or starting off the charcoal, that one is a thing of the past, I just sit down, switch on my gas, and cook comfortably!"* (User H in Nthimbiri)

User E in Kithirune has also portrayed how having a time efficient cooking fuel benefits the entire household: his children are rarely late at school since bathing and cooking is faster.

The importance of the outlined benefits was observed to be differently pronounced by genders. The benefit of savings on fuel costs was always brought up by men groups as the very first benefit answering the question. Meanwhile, women did mention the savings as well but would first name availability or convenience related issues. Women also elaborated in greater detail on how biogas can be more convenient than other fuels. This is consistent with the gender roles in the family, as respondents indicated themselves: housewife is the one to benefit from biogas in terms of less work for getting the fuel and cooking, while men tend to be named as the beneficiaries from the financial perspective. However, many times it was claimed that the entire family benefits since food is prepared faster and money can be channelled to other needs.

Other biogas benefits

The other benefits described below are those which were not equally dominant in all the discussions with non-users, but were recognized either by users or in the literature.

One important benefit recognized by several users is the **financially unrestricted use** of biogas:

> *"I can use it the way I want without the fear of cost on it going off like with LPG."* (User C in Kerarapon)

Financially unrestricted access to energy also means that a household becomes immune to energy price fluctuations. For example, firewood price can increase during the rainy season (ETC Group, 2007) or due to the increasing scarcity of the biomass fuels. It is termed as financial energy security as it diminishes a household's vulnerability to energy price changes (Jain, 2010). This should be a relevant attribute for a typical household in Kenya which spends a significant share of income on cooking energy (see the Footnote 2) and a change in a cooking fuel price can

significantly affect its financial situation. This benefit could be promoted more, since it was not explicitly recognized by non-users. However, there are reasons to infer that it may be appreciated as one user commented about her visitors:

> *"They like it {biogas} so much because it is not regulated! The one for LPG: you use little to save energy to cook the following day."* (User G in Nthimbiri).

Bio-fertilizer, which is a by-product of biogas production, yielded different responses among non-users. Most non-users agreed that bio-fertilizer is better or at least as good as cow dung, which they normally use as fertilizer on the farm. There were a few groups claiming that cow dung is better though. However, only in a half of the FGDs, bio-fertilizer was mentioned as one of the benefits without us specifically asking about it, which infers that many non-users may not associate it with biogas. Notably, most users admitted that fertilizer was an unexpected benefit for them because they discovered it only after the adoption. Moreover, the users claimed having a very good effect of the biogas fertilizer on their farm produce, better than with cow dung, which is in line with the literature.

Improved **health** conditions as a result of using biogas were not directly associated with biogas use as most often it was offered to the discussions by the FGD facilitator. Both non-users and users did not bring up this benefit themselves, but responded to our probes by acknowledging it. When asked about health, respondents would mostly refer to smoke explaining that biogas cannot affect one's health because it has no smoke. Many respondents named charcoal as the worst possible performer since it emits carbon monoxide and thus can kill. However, most of the answers were just witnessing the fact that there is no smoke, but not elaborating about possible respiratory or eye complications in greater detail.

Another item dominant in the discussion on health was that biogas use carries a lower risk of explosion compared to LPG. The issue was brought up only by some users and non-users in the peri-urban Nairobi since they are more familiar with natural gas use. Biogas was considered to be a safer substitute:

> *"It is also not as risky as the LPG for the latter can burn the house and has smell."* (FGD: Kabete women)

One more health benefit was mentioned by both, the non-users and the users, in interior Meru. They said that biogas would benefit a housewife through relieving her work:

> *"Her health will improve since she is not carrying firewood."* (FGD: Kithirune men)

Notably, this issue was mentioned only in the interior fieldwork where most of the respondents indicated using firewood.

Both, non-users and users, agreed that **sanitation** in a household would increase once biogas is there, though the issue was rarely mentioned by respondents themselves. They admitted that there is less smell and flies when cow dung is stored inside of a tank rather than in the yard:

> *"Since it is directed to one place, it will not be everywhere thus increasing the cleanliness of the home."* (FGD: Kianthumbi women)

However, the improved cleanliness was associated with amenity benefits rather than with better health conditions and the lower risks of the parasitic diseases, as the literature suggests.

Environmental benefits of biogas were more often probed by us, than mentioned by respondents themselves. There were two issues recognized. The most mentioned environmental impact of biogas use was the conservation of trees:

> *"There will not be cutting trees, thus conserving environment."* (FGD: Kabete women)

The high frequency of the deforestation issue being mentioned indicated high awareness of the problem among both non-users and users. However, most of the respondents explicitly stated that it does not influence their decision on cooking fuel choice. The second issue mentioned by several FGD groups was that smoke pollutes the environment; therefore, if there is no smoke,

many respondents would think there is no environmental harm. As a result, gas and biogas were perceived to be equally environmentally friendly:

"It is only carbon monoxide that is environmental unfriendly." (FGD: Kerarapon men)

This indicates that health and environmental issues may not be clearly distinguished in people's minds. Notably, the issues of climate change or carbon emissions were not mentioned a single time during our fieldwork.

Overall, non-users exhibited a level of understanding of all the biogas benefits presented in the literature review. Only the contribution of biogas to lower carbon emissions was not recognized neither by non-users, nor users, indicating a possible low awareness of the issue in the society. Moreover, directly observable benefits, like monetary and time savings, availability and convenience generated more elaborate discussions and were more often brought up by respondents than the other benefits. In addition, the directly observable fuel attributes, like cost, availability and convenience were consistently referred to as the most important criteria for the choice of a cooking fuel. Meanwhile, health and environment related benefits, though commonly recognized, were stated as not considered for the choice of a cooking fuel.

There were a few differences observed in the discussions on biogas benefits among different focus groups. The most pronounced were the gender differences on the recognition of savings and convenience benefits, coinciding to the different gender roles in a household (see above). In addition, the non-user perceptions of health effects indicated that perceived biogas benefits may be different depending on the main fuel used: biogas was more compared with gas in the peri-urban settings, while in the interior Meru it was mostly put side by side with firewood. There were no evident differences on biogas benefit perceptions between non-users living close versus far away from biogas.

4.1.2 Financial effects of biogas use

"It's not expensive, only needs knowledge and money" (FGD: Timau women)

Though all the respondents recognized the savings arising from biogas, many would become confused when asked about the cost of biogas. On one hand non-users tended to comment about biogas as a very expensive option, used by the rich people; on the other hand, all respondents recognized that after installation, the cooking fuel costs are minimal. The underlying reason may be that biogas cost structure is essentially very different from other cooking fuels: biogas adoption involves high initial costs and afterwards the maintenance costs are negligible; meanwhile, the use of other fuels, like charcoal, results in constant flow of costs. Respondents recognized this difference, but it was difficult for them to compare the costs of biogas and other fuels. Therefore their descriptions of biogas costs comprised contradicting features:

"It is cheaper than firewood, but it is expensive to install." (FGD: Kianthumbi men)

"It is somehow economical. Once it is complete, no other expenses to be incurred." (FGD: Timau men)

"Not expensive in using but when constructing it." (FGD: Kabete women)

"You can't start with half {of installation}" (FGD: Ruku men)

A simplified visual fuel cost comparison was carried out with non-user groups to analyze biogas costs and benefits, in terms of savings. A drawing was made in the process of each discussion, portraying the re-incurable cost for charcoal (see Figure 7, red objects) and a lump sum costs of biogas and re-incurable savings thereafter (see Figure 7, green objects). The participants were asked, first, to indicate how much a biogas digester would cost and then what monetary savings could arise from biogas use. Finally, we asked the respondents about a possible pay-back period and their overall opinion on biogas costs.

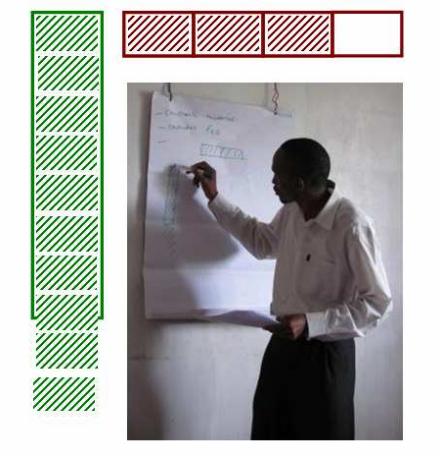

Figure 7. Visual fuel cost comparison.

Interestingly, besides the obvious savings on cooking fuels, the savings on reduced *"medical bills"* and time were often mentioned. It indicates that users may recognize health problems and the opportunity costs of time as monetary. The opportunity costs of time are important to recognize, since firewood is possible to collect for free, however, there is a considerable amount of time to be invested. Another recognized saving was on fertilizer costs, which was more recognized by female FGD participants.

When non-users were asked to estimate a payback period (PBP) based on the information discussed[7], their answers ranged from a half to six or *"many"* years. The answers were vague and lacking argumentation, which indicated that the respondents were mainly guessing. However, about half of the groups pointed out that a PBP depends on cooking energy usage, which showed that some respondents understood the concept. Still there were several answers that PBP depends on one's stability of income, implying that some respondents were thinking about the time to recover their level of savings rather than recovery of the investment costs.

After the visual cost comparison, many FGD groups concluded that biogas in the long run is cheaper. Women tended to be more enthusiastic about this conclusion, while in many male groups there were discussions and opposing arguments pointed out. First, the time value of money was referred to, and some respondents claimed that the PBP may be unacceptably long:

> *"May be in five years you will have spent Ksh 120,000 to buy charcoal but you know that is in a span of 5 years and then Ksh 120,000 is at once"* (FGD: Kerarapon men).

In addition, many respondents pointed out that it is hard to acquire a lump sum at once, which is a recognized challenge in the previous literature and we had a separate discussion on this issue (see Section 4.2.2). Moreover, some respondents questioned the concepts of PBP and opportunity costs: whether the savings can actually be counted up as covering the investment costs because biogas does not generate income, it only reduces expenditure:

> *"It sounds expensive because you will not get that money."* (FGD: Timau men)

Lastly, some respondents after the exercise did not change their perspective on biogas costs over time and stayed with the common initial position that biogas is expensive to install but cheap to use.

An important observation was that FGD participants learned most during this part of discussion. Their comments made us realize that they have never given this depth of consideration to their fuel choice before:

> *"The explanation on cost implications made me decide that biogas is good."* (FGD: Kabete men)

[7] The discussion involved nothing more than simply matching the costs against the accrued benefits. Discounting was not part of this exercise.

> *"It is only that people have not been taught about it, they would have installed theirs."*
> (FGD: Kithirune women)

Some expressions indicate that Kenyan respondents may not be considering the cumulative costs over time when making a fuel choice:

> *"You usually don't see the small amounts you spend on buying fuels, but in real sense if you sit down and do calculations, you will know it is a lot of money."*
> (FGD: Kabete men)

Most of the interviewed users also reported that they did not make any calculations on their biogas investment and payback, neither at the point of their decision to adopt, nor anytime later:

> *"You know, sometimes when you do something and succeed you can not bother about the money again. (...) Like we Merus we don't count for what you have already used"*
> (User H in Nthimbiri)

To sum up, after discussing the financial costs and benefits, both users and the majority of non-users agreed that biogas generates savings to payback for the initial costs and in the long-run it is cheaper than other cooking fuels. However, in our observed cases many respondents stated that they never had thought about fuels in this way: accounting for costs and benefits over time. This may indicate that the financial effects of biogas may not be recognized by non-users, if not explained personally. It could be that potential users consider biogas only on the basis of its installation costs, and refer to it as *"expensive"*, while not accounting for its financial effects after the adoption.

4.1.3 Challenges of biogas use

"If you are lazy you will not feed the digester" (FGD: Kithirune men)

When asked about challenges of use, non-user answers were mostly laconic and uncertain. The most prevalent issue, brought up by every second group, was the constant need to ensure a sufficient supply of cow dung. The other occasionally mentioned issues included: the risk of explosion (mentioned by different non-users from those who saw biogas as safer than natural gas), the regular need to feed the digester, the attention needed to prepare dung to prevent failure. However, different answers were provided by different groups, with little elaboration or discussion, which indicated that participants did not know much of the requirements that come along with biogas use. Notably, there were no cultural acceptance issues concerning the use of cow dung to produce cooking fuel encountered in the discussions. Only the use of human waste from latrines was commented with suspicion; however, human waste use in domestic biogas applications is not significant due to its low volumes.

To elaborate more on the challenges of biogas use, we have used probes, asking what is needed to keep a digester running, which was posed as a neutral question about the requirements of sustainable biogas use. Almost all of the groups knew and accented the need to feed the digester, which is in line with the main recognized challenge of use: to ensure the supply of dung. The other commonly mentioned duties were to remove the impurities from the dung and apply correct dung/water mixing ratio. It was observed that the non-users living in the locations with biogas and men groups tended to elaborate more on the requirements for biogas use issues than women or the respondents from locations without biogas. In general, the discussions on the topic did not share the notion that it is hard to keep a digester running without problems.

Notably, only a few groups, actually all of them being men groups, knew about a case of biogas failure somewhere, but did not express a belief that technology is in principle difficult to maintain. Contractor mistakes as possible reason for failure were mentioned only one time throughout the entire fieldwork. On the contrary, the comments about contractors' competence were either positive or uncertain, because few respondents had a contact with them. These

observations contradict the observations in the previous research that "bad name" of biogas is wide spread and deters potential users from adoption (ETC Group, 2007).

Meanwhile, users, when asked about challenges of biogas use, consistently brought up one issue: the responsibility to feed the digester regularly. Users reported always having to remember it, and arrange for it if one has to leave the household:

> *"My mind is always fixed that I have to feed the biogas."* (User C in Kerarapon)

However, this was not seen as a great disadvantage of biogas, since the use of other fuels brings other duties:

> *"Going for firewood from the forest every day or feed it {biogas} just from here with a wheelbarrow around - which is easier?"* (User B in Ruku)

Likewise, most of the users denied our probes, if biogas brings more work to the household. The most mentioned duties to keep the digester running were the same as listed by non-users: regular feeding, removing impurities, correct water/dung ration, also avoiding chemicals getting into the dung. Naturally, users could elaborate more on the precautions to be taken, since all of them indicated having received verbal instructions from their contractors.

Moreover, a few users have elicited an important condition for sustainable biogas use, which is the attitude of all household members towards biogas adoption:

> *"We agreed as a family, this is what we want"* (User B in Ruku).

Accordingly, if someone adopts biogas without such an agreement, there will be times when other family members have to feed the digester, and they could do it with negligence, which might bring failure. Equally important is to ensure that if workers are hired to feed the digester, they can be trusted and instructed well:

> *"If people refill it in a hurry or they are not very honest, if they just put the dung as it is; it is going to block"* (User A in Ruku).

In summary, non-users did not indicate any challenges of biogas use as deterring. The only challenge mentioned more often was the need to have enough cow dung for the digester, which refers to one's technical potential. The non-users were aware of the main technical requirements to run the digester sustainably, but did not recognize them as cumbersome. Users as well did not bring up any challenge of biogas use, except for a duty to feed the digester regularly. In addition, users have pointed out the coherence of household members regarding biogas adoption as an important factor for sustainable biogas exploitation.

4.2 Perceived challenges of biogas adoption

In the focus groups with non-users, after discussing the benefits of biogas, we used to switch the course with a simple question: so why haven't you adopted biogas so far? This section discusses the challenges of biogas adoption, which may be obstructive even if a household has a recognized preference for biogas.

There were two reasons for the biogas non-adoption dominating in the non-user answers: the lack of information and the lack of money. Both of these challenges were stated by nearly all non-user groups, and it was hard to infer which one was more important. The lack of information as a barrier to biogas adoption was more pronounced by the respondents in the interior area around Meru, while FGD participants around Nairobi, always mentioned lack of money as the first reason for non-adoption. This could be because people in the interior feel less exposed to any outside actors, including promoters of biogas and contractors. Also the biogas users interviewed in the interior were more similar to the non-users in the neighbourhood in terms of income. Meanwhile, higher income inequality around Nairobi may incline to explain all the differences by the availability of money.

Among other occasionally mentioned challenges, there were the lack of space for a biogas installation and lack of cattle to produce sufficient input, both of them referring to the technical potential of biogas adoption.

Users were also asked about their experienced challenges of biogas adoption. However, since they had successfully adopted the technology, their answers in nature related to more technical details of the construction process. Several users did recall having troubles to collect the funds needed for their installation. The common reason was that the actual costs incurred during the process of construction exceeded the cost estimates provided by the contractors in advance. Therefore the users found themselves to be short of funds in the middle of the construction. In addition, a few users mentioned that construction took longer than expected, and also indicated having had difficulties to obtain the kitchen appliances suitable for biogas use. Users did not mention that obtaining information has been a challenge.

The underlying rationales of the two dominant challenges are presented in separate sections below.

4.2.1 The challenge of information

"If you give me information, I will go and plan for it" (FGD: Kianthumbi women)

In general, non-users complained that the available information is insufficient, thus preventing them from thoroughly considering the option to adopt biogas. There was an expressed need for more information on the side of biogas use:

> *"{We need} to know the advantages and disadvantages"* (FGD: Kianthumbi men)
> *"I heard explaining on the radio. But he didn't explain how this can be used, he only explained in terms of size: the smallest will cost this, with the lighting it will cost the other, and when you value those costs it's too much and you decide to leave it."* (FGD: Ruku men)

In addition, the non-users' comments during the discussion of the financial effects indicated their willingness to know more on the financial comparison of biogas and other fuels.

When asked about possible sources to obtain more information about biogas, most of the groups referred to *"the ones who have it"*, i.e. biogas users. Biogas users may be named as the most important source of information since it was mentioned as the very first answer by nearly every focus group. Moreover, the importance of actually seeing a digester was stated by non-users and reiterated by the stories of users about their visitors and their questions asked:

> *"How the cow dung can produce gas? Really? How is it burned? Can I see how is it burned? Sometimes they even can't believe that the fire we are getting they can see is from the cow dung."* (User A in Ruku).

Correspondingly, most of the users interviewed reported having visited another user before deciding to adopt biogas themselves.

The other commonly mentioned informants were the contractors, or *"people who build it"*, also sometimes referred to as *"experts"*, which indicates the good opinion about the competence of the biogas suppliers. However, the comments regarding the accessibility of contractors were twofold:

> *"You can invite them to come and advise you"* (FGD: Kabete women)
> or *"They can charge you if they teach you"* (FGD: Kerarapon men).

The latter and several other comments indicated that some non-users may not be keen to contact contractors for more information, since then they may feel an obligation to continue with adoption.

Moreover, in most cases, non-users knew only one contractor in the area, who had build a digester nearby. As expected, the non-users in the areas without biogas typically were not aware of any active contractors. In the locations with biogas, men focus groups were observed to know

a contractor more often than women groups. Overall, the comments on contractor availability were consistent with the literature findings that biogas supply capacity is insufficient in terms of active artisans and the promotional activity (ETC Group, 2007).

Other possible sources of information mentioned were: media, local governmental divisions - agricultural offices, also books, secondary school curriculum, church, and self-help groups. Surprisingly, NGOs were rarely mentioned as a source of information. Even when we asked specifically about them, a half of the groups were not aware of any. In the fieldwork of peri-urban Nairobi where many digesters were built with NGO provided subsidies, only every second group of non-users knew that NGOs were active around. Furthermore, those participants who knew an NGO, and even some users who had received a subsidy financed by an NGO, often could not say the name of the NGO, which is crucial for an NGO's activities to be promoted.

Lack of information or lack of interest?

Designing the fieldwork it was not expected to encounter a challenge of information when talking to the respondents who lived nearby a biogas user. However, having a biogas user around showed to make less difference on non-users' exposure to biogas than expected. Though most non-users did name biogas users as the best source of information, there was no major difference between the importance attributed to the challenge of information in the locations with biogas users and the locations without any.

In the locations without biogas users, the complaints about lack of information were strongly pronounced, and sounded somewhat desperate:

> "*R1: You can't think of a thing you haven't seen.*
> *R2: You even don't know who can help you.*
> *R3: Currently in the area we have no source. We have no reliable source."*
> (FGD: Kianthumbi women)

However, the comments expressed by the non-users living in the neighbourhood of biogas users, who most of them personally know, were not much different. The FGD participants in the locations with biogas complained about no access to information, though the most referred source of information, a user, was available next door:

> "*I didn't get its benefits since I have not been told about it."* (FGD: Kithirune men)
> "*We never get someone to give us information."* (FGD: Kithirune women)

Moreover, the phrasing of the comments above was very passive, as if getting the information to them would be someone else's responsibility. Furthermore, the passive behaviour towards obtaining more information on biogas was observed in the shares of FGD participants who had seen a biogas digester (see Table 4). Apparently, almost all the FGD participants living in the locations with biogas installations personally knew a biogas user. In spite of that, only every second of participants had seen a biogas digester. If compared to the FGD participants living in locations without biogas, only one of three participants knew a biogas user somewhere, but still about half of them had seen a digester somewhere. This indicates that having a biogas user around may not significantly increase non-users' exposure to biogas technology in the surrounding area.

Location	Group	Biogas present	Knows a user, %	Seen biogas, %
Nairobi	Ruku men	YES	100%	67%
	Ruku women		100%	55%
	Kerarapon men		56%	44%
	Kerarapon women		100%	44%
	Kabete men	NO	14%	57%
	Kabete women		36%	45%
Meru	Kithirune men	YES	83%	67%
	Kithirune women		100%	33%
	Timau men		86%	43%
	Timau women		100%	86%
	Kianthumbi men	NO	38%	50%
	Kianthumbi women		25%	38%
Locations with biogas			**91%**	**55%**
Locations without biogas			**28%**	**48%**
Total			**68%**	**52%**

Table 4. Non-users affiliation with biogas.

Interestingly, the fieldwork locations without biogas (Kabete and Kianthumbi) were within 5 km distance from the researched locations with biogas digesters (see the maps in Annex E). Nevertheless, the participants did not indicate knowing a biogas user in those particular locations, which may be a sign of how far information about biogas users can spread.

This study did not specifically address the reasons why the neighbours of biogas users did not visit the installations though they were aware of their existence and showed recognition of biogas benefits in the discussions. Such behaviour seemed very passive, contributing to the passive phrasing of the complaints about lack of information. Also a precedent of an ignorant community reaction was recalled in one FGD:

> *"My neighbour {a user} invited people to learn but they ignored."*
> (FGD: Timau women)

In contrast, biogas users reported on their proactive efforts to find a biogas user nearby, in order to see their digester and obtain more information about biogas.

One of possible explanations elicited in several discussions was that there may be a lack of interest or motivation lying behind the claims of *"lack of information"*. Some of non-users groups highlighted the *"lack of interest"* as one of the differentiating factors between biogas users and non-users:

> *"The ones that are building {biogas} are those who have gone and seen it. They were given the information and <u>became interested</u>"* (FGD: Kabete women).

There were also other statements pointing to the *"lack of interest"* as a separate issue, next to the *"lack of information"*:

> *"You may have information, money but you don't have the interest."* (FGD: Kerarapon men)
> *"You first get the interest, then you work for information"* (FGD: Kerarapon men)
> *"R1: Most people don't have the correct information.*
> *R2: Lack of information, thus no interest."* (FGD: Kabete men)

It seems to be similar to the chicken-and-egg problem, which comes first the interest in biogas or the information? Apparently, some information is needed to generate the interest, meaning to establish biogas among the options considered for a cooking fuel choice. Further, the interest is necessary to motivate a potential user to obtain more detailed information and actually consider the possibility of biogas adoption. Consistent with this scenario, some of the users interviewed told that they became interested in biogas based on information from books or media, while finally decided to adopt it after visiting a biogas user themselves. Usually the visited users were

also the source of contact of a contractor active in an area. These observations suggest that an appropriate way to promote biogas should focus on two stages: generating the interest and providing access to biogas users or suppliers for those interested.

4.2.2 The challenge of funds

"With money you don't get any challenges." (User H in Nthimbiri)

Lack of money for biogas adoption is the most tangible challenge, widely referred in the literature on biogas adoption. In FGDs money was always declared as a reason for biogas non-adoption, often being put forward as the very first reason, especially by the non-users around Nairobi:

> *"I knew how to do it, I even saw it and became interested but I don't have money"* (FGD: Kabete women)
> *"Given money, a month wouldn't be over without it {biogas}."* (FGD: Kerarapon women).

Moreover, when asked to describe the people who have biogas, non-users mostly characterized them as being *"rich"*, which is also referring to the same issue of income:

> *"They are in a position to borrow loans."* (FGD: Kerarapon women)
> *"R1: When he has money he can know more than others. And when you hear about something and it's good, and you have money, you can do it.*
> *R2: They have no much responsibility like us because they finished educating their children."* (FGD: Kabete women)

The cited complaints about lack of money may be put forward for two different reasons. First, biogas might be perceived as an expensive fuel option, considering its high cost without recognition of the savings, as discussed in the Section 4.1.2 [8]. Second, even if biogas is recognized as a cost-efficient fuel, there is still a challenge of obtaining the needed funds for the construction. To tackle the latter issue separately, non-users were asked to assume that they decided to adopt biogas, and discuss the possible ways to obtain the necessary funds.

The most referred sources of funds were accumulating savings or taking a loan from a bank, a cooperative, or a micro-credit institution, especially from women saving groups locally called "merry-go-round". Among other sources occasionally mentioned, there were loans from informal sources, like acquaintances, sales of one's assets, like cattle, and donor funds. Most of the groups knew 3-4 possible sources of credit, and were aware of the conditions to be fulfilled along. Interestingly, donations or subsidies as a source of fund were rarely mentioned, and only in the interior areas, thus not mentioned at all in the FGDs of the peri-urban Nairobi, where most of the NGOs are active.

Savings or credit?

Our group discussions with non-users elicited some perceived tradeoffs between using savings and taking a credit for an investment into biogas. It may appear that it makes sense to borrow to obtain a biogas installation since later it generates tangible savings that can be used to repay the loan. However, FGD participants showed no clear preference for credit versus savings.

Savings were seen as a safe track, which would be preferred by many respondents if it was possible to withhold some income from spending on necessities:

> *"It is better to save. Through it is not possible."* (FGD: Timau women)

There were a few reasons mentioned why it is difficult to save.

[8] The question on the reasons for not-adopting biogas was always posed before the discussion on financial effects; therefore, at that stage of discussion respondents were not familiar with the cost-benefit framework (see 6.3 Annex A for FGD facilitator guidelines).

First, the groups referred to the constant pressure of unfulfilled needs and competing priorities, which makes it very hard to save:

> *"Not that we are so poor but there is the priority of activities"* (FGD: Kabete women)
> *"Because you have children needing fees and other personal expectations"* (FGD: Kerarapon women)

It is necessary to make a withstanding determination to save for biogas in order to actually acquire the needed amount. *"He prioritized biogas"*, this is what Timau women said about their neighbour, User J, who was similar to them in terms of income, but he got an interest and made a priority to save for biogas. This finding was consistent with another qualitative study of households in Kenya, which claims that biogas may not be simply unaffordable, but rather there are other priorities ranking higher for a given household, especially referring to the middle-higher income households (ETC Group, 2007).

Second, non-users claimed it to be very hard to maintain stable priorities over time due to unstable income. Since most of the respondents were relying on farming activities as their main income source (see Annex D for Respondents data), the instability of weather affects the harvests and thus income, making it even harder to save when balancing against short-term urgent needs:

> *"Saving culture in Kenya is among the poorest in the world. The needs are many and there is crop failure. You channel money into other ways."* (FGD: Timau men)
> *"You may save and get other needs in between and fail to construct biogas."* (FGD: Kianthumbi women)

Moreover, in some comments it could be sensed that there is an overall lack of confidence in one's determination to save, which could come from a life-long history of balancing the fulfilment of many needs against limited income:

> *"You know I can save. But then it comes a time when I get something and I buy it."* (FGD: Ruku men)

Due to all the factors listed above, non-users tended to come to the conclusion that saving is difficult, and even if pursued, it would take a considerably long time:

> *"You can save and be old while you have not installed"* (FGD: Kianthumbi women)

On the other hand, **credit** was appreciated for it provides funds to construct biogas immediately, and about half of non-user groups showed preference to credit over savings.

> *"If you don't take risk you will not improve."* (FGD: Kithirune men)
> *"Because saving all this money will take around ten years and with the other one {credit} it will be built at once, then I start paying back at every end of month."* (FGD: Kabete women)

The respondents exhibited awareness of the many conditions to be fulfilled to get credit, and the cited interest costs were realistic, ranging between 10-30% per annum. However, credit was rarely referred to as very costly, which may also hint that respondents do not consider the total cost paid over time. Some respondents indicated that credit is somewhat difficult to obtain due to all the conditions, but not impossible; a few times it was claimed to be easily accessible.

The foremost cited deterrent of credit was the perceived risk of not being able to pay back:

> *"Getting a loan is easy but the problem is to pay it back."* (FGD: Timau women).

There was an often stated fear of one's inability to save in order to return the loan, which had the same underlying reasons as accumulating savings: many competing needs and unstable income, depending on farming:

> *"Even loan is the worst because if the rain fails you are not able to repay"* (FGD: Timau men).

In addition, taking a credit for biogas was perceived to be different than taking a credit for a business investment. The explanation was that biogas adoption does not generate additional

income, it only reduces spending. Some respondents pointed to this issue claiming that it is harder to accumulate savings and pay back without an increase in one's income.

Being unsure of their ability to payback the loan, respondents tended to associate credit with the worst possible scenario, one's property loss. It may be that the possibility of loosing everything was perceived as threatening enough to outweigh any potential benefits of biogas adoption:

> *"If I am unable to pay they will take my farm"* (FGD: Kabete men)
> *"I can take loan and not able to pay. And then your things are confiscated..."* (FGD: Timau women)

In summary, there was about the same amount of arguments provided on the problems with savings as with credit; therefore, no clear preference has emerged from the FGDs with non-users. However, the female groups more often indicated a preference for credit, pointing to a long time needed to save, as their main reason. Meanwhile, men were more cautious about the risks associated with credit. There were no clear differences observed in preferences for funds between different locations: with vs. without biogas, as well as, peri-urban vs. interior locations. Finally, some of non-users were not seeing biogas adoption as an available option at all: since it is hard to save and risky to get credit, one chooses *"to buy charcoal as normal"* (FGD: Ruku men), which once again proves the significance of the challenge of funds to biogas adoption.

The number of users interviewed was insufficient to make any generalizations, and everyone's situation was unique. Some of them had enough savings to finance the installation, some relied on credit. Overall, the users interviewed mostly had higher income than the majority of non-users. Some users, however, reported on the need to take credit because the biogas adoption opportunity came suddenly, along with a subsidy offer from a promoting organization, and their savings were not available immediately.

Ways around

There were a few ideas that emerged in the discussions with respondents on possible ways to overcome the challenge of funds.

In several FGDs non-users were bringing forward the idea of a community saving fund specifically for biogas construction. Such funds are usually facilitated by a micro-finance institution which organizes a group of people willing to save together for a common purpose. The group members regularly contribute with an agreed amount of money, and decide the order of members to use the fund. Responsibility and reputation in front of a community keeps the incentive for the group members to keep their obligations. However, such funds are commonly used for school fees and other relatively small expenses, while biogas installation costs are considerably higher, and such fund would take time to accumulate the needed sums.

Another idea, suggested by a few users, was to save for biogas, by buying and slowly accumulating the materials needed for construction. Some of the users have bought their materials over a period of one year. This helped them to distribute their spending over time, and reduced the liquidity of the savings, turning them into tangible assets for biogas adoption.

Gas for Cash

"Gas for cash" was an alternative business model that was offered for respondents' consideration and feedback, as the last item in the discussion. The main idea was to provide a theoretical opportunity for households to obtain biogas avoiding the high up-front costs.

One of the possible ways to do it is to have a (business) organization installing a digester at a household's home and writing a contract of use with a household. The contract commits the household to pay for the gas used based on the time of usage or on the amount of gas used. The price to be paid and the duration of the contract would be subject to a business marketing plan, along with the management of arising business risks and service costs. However, in principle, such a model would mimic the cost structure of the traditional fuels.

This option was applauded by most of the non-users and users, and similar rationales were put forward by all respondent groups. They were enthusiastic about their willingness to participate in such a project, since it eliminates the challenge of funds. It was perceived as a type of credit; though in this case a user may be more flexible in its repayment schedule, if the payments depended on the amount of biogas used. Respondents stated to understand that over time they would pay for the cost of the digester and for the company service; however, such an acquisition option was not perceived as threatening as a bank. The latter may be a business risk, though it can be managed with help of contracts and establishing collaterals.

The most crucial stated condition to engage was the ownership of biogas that should be granted after some agreed period of time or the agreed amount of accumulated payments. The length of the period or the intensity of repayment was suggested to be customized according to a household's income and preferences. It was generally accepted that the user is the one to feed the digester, since otherwise it was recognized that the service provider would incur additional costs and raise the charges. However, there should be a stated deduction of the charges to acknowledge that the user is contributing to biogas production.

In summary, even though, the "gas for cash" model needs to be well designed to balance against its business risks, which is outside the topic of this study, it is definitely welcomed by the potential customers for it eliminates the challenge of funds. Such a model may be provided for individual household or for a community as a shared installation. It can be carried out by a profit oriented business entity or an NGO oriented to self-sustained projects rather than aid.

5 Discussion

The following section provides the author's considerations of interrelations and implications of the findings presented in the previous chapter. Four cross cutting themes have emerged and are discussed below.

5.1 Is there a preference for biogas?

It is important to examine the preference for biogas use and understand the underlying factors for it. The previous literature has not thoroughly addressed the perceptions increasing or hampering the preference for biogas. Considering all the attributes of biogas use presented in this study it may be inferred to what extent biogas is perceived as an attractive cooking fuel option. According to the author's interpretation, it is likely that the perceived benefits of biogas use by far outweigh the use related challenges for the reasons provided below.

First, non-users demonstrated a similar level of recognition of all the biogas benefits that were acknowledged by users. It suggests that all the adoption drivers significant for biogas users were recognized. In addition, the list of the benefits perceived by non-users contained all the biogas advantages cited in the literature, except for the lower carbon emissions. Notably, the biogas benefits that were most recognized by non-users, namely, savings, availability and convenience, coincided with the most important stated criteria for the cooking fuel choice: costs, availability and convenience. However, non-users showed confusion when asked to evaluate the cost of biogas, being unable to compare one-time costs to the benefits accrued over time. The perception of biogas costs may be decisive for biogas preference since cost is usually stated as the most important criterion of a cooking fuel choice.

Moreover, there were no challenges of biogas use perceived by non-users as important enough to reject the option of biogas. Non-users were aware of the most important requirements to run a biogas digester, but did not evaluate them as demanding or deterring. Contrarily to the previous research findings, most non-users were not aware of high failure rate of biogas digesters and did not have negative comments regarding the competence of contractors. Consequently, this was not affecting their preference for biogas. It should not be understood that biogas failure incidents do not bring any harm to the biogas sector; however, our findings indicate that the effect on non-users' perceptions may be local rather than widespread.

Considering all of the above, it can be inferred that biogas should be desired as a cooking fuel: the most important benefits were widely recognized and no challenges were pronounced as deterring from biogas adoption. The main attribute balancing the outcome is the perception of biogas financial effects.

5.2 Is biogas cheap or expensive?

Cost was stated to be the most important criterion of a cooking fuel choice for the majority of non-users. However, it was not trivial for the respondents to weigh biogas costs against the other cooking fuels since the cost structures are essentially different and the time dimension is involved.

The visual comparison of the financial effects of cooking fuels was generally accepted as a valid argument of biogas advantage in the long run. However, the respondents indicated that they had not considered the financial effects of fuel cost accruing over time before. Moreover, there were doubts expressed if the savings resulting from biogas use can actually be accounted as monetary benefits.

Evidently, the cost structure of biogas implies its adoption decision to be an inter-temporal choice between: paying the cost in advance for the benefits to be accrued in the future (if opting for biogas) and paying little for the current consumption (using the traditional fuels). The understatement of future costs or benefits may indicate a high discount rate to be used (Wilson, & Dowlatabadi, 2007). On the other hand, the lack of recognition of long-term financial effects may be attributed to lack of education, as some studies show that biogas adoption correlates with higher education (Mwigiri et al., 2009). However, there may also be a cultural imprint: to consider the financial effects incurred at different times separately. Likewise, the users interviewed indicated that their biogas adoption was not a calculated decision, and they were not interested to find out if their investment cost had been recovered.

There could be immense implications if the savings arising from biogas adoption are not considered together with the costs. The commonly used adoption decision models are based on the assumption that consumers are able to use and act on the outcomes of cost-benefit analysis (hereinafter, CBA) (Mwigiri et al., 2009; Ni & Nyns, 1996; Walekhwa et al., 2009). Since our observations indicated that non-users may not consider financial implications accrued over time, it may be that CBA outcomes are not influencing their decisions as directly as it is assumed.

For example, a few studies state that the preference for biogas is dependant on the costs of other cooking fuels (Ni & Nyns, 1996; Walekhwa et al., 2009). However, if the CBA framework is not relevant to households' considerations, the prices of other cooking fuels may have little impact on their preference for biogas. Walekhwa et al. (2009) employed a regression on biogas adoption among households in Uganda as a function of a list of socio-economic factors, including local prices of firewood and kerosene. Higher prices of the fuels turned out to be positively correlated with biogas adoption and statistically significant. However, the strength of these contributions to the adoption outcome appeared to be very small since their respective odds ratios were close to the exact value of one (<1.005). Such values of the odds ratios indicate that the differences in the fuel prices were not affecting the likelihood of biogas adoption to a considerable extent. Actually, their affect on biogas adoption was the smallest among all the significant variables in the study.

Moreover, the doubtful relevance of CBA to household considerations may shield a new light on subsidy applications for biogas promotion. A subsidy which covers the costs only partially may not generate a wide interest among households since it does not change the costs structure of a biogas project per se. A subsidy does improve the returns on biogas, but people still need a lump sum of money, which may be perceived as high or expensive. However, several interviewed users reported that a subsidy offer had created a sense of urgency to pursue the opportunity to obtain biogas a little bit cheaper.

Overall, the perception of biogas financial effects maybe crucial to determine the preference for biogas: if biogas installation costs are viewed as separate from the subsequent savings, biogas stays out as the most expensive cooking fuel option, and thus maybe rejected before a more detailed consideration. Therefore, the perceptions of long-term financial effects and the ways to communicate them should be researched more.

5.3 Reconsidering the challenge of information

Though lack of information, knowledge or awareness are commonly stated challenges of biogas adoption in the literature, designing this study it has been attempted to control for it. First, only the non-users familiar with biogas as a cooking fuel were recruited to the FGDs, in an attempt to avoid lack of awareness in the discussion groups. Moreover, most of our fieldwork was organized in the locations where biogas users live, thus targeting the non-users who were more exposed to the technology. However, the study yielded unexpected results bringing up a well pronounced challenge of information, even in the locations with biogas users. In addition, another related issue was highlighted: a lack of interest to acquire information.

Despite the fact that biogas users were the first and foremost referred source of information on biogas, the issue of lack of information was equally well pronounced in the locations with biogas users and in the locations without. Moreover, the share of the non-users who had seen a biogas digester was similar independently on the presence of a user in a location. This suggests that the presence of biogas users may not increase the exposure to the technology among the neighbours. Though the reasons for the observed behaviour were not discussed with the respondents, it may be speculated that it is either the users who are not willing to be open and promote biogas among their community or the neighbours in the surroundings are not interested enough to acquire the information.

In the first case, biogas users, especially if their installation is subsidized, should be given incentives to organize events to introduce biogas in their community. It should be also in the interest of biogas contractors to agree with their clients to organize presentations for non-users.

In the second case, there is a lack of interest among non-users, which is consistent with the passive connotation observed in their comments, and the references to the issue of lack of interest by respondents themselves. Lack of interest is not a well addressed issue in the previous literature on biogas adoption. The main information related issues tackled are lack of awareness (ETC Group, 2007; Mwakaje, 2008; Mwigiri et al., 2009) and lack of technical knowledge (Jain, 2009). Ni and Nyns (1996) developed a model of factors influencing the internal motivation of an adopter. The model puts forward the technical potential and relative advantages of biogas use, including the financial effects, as the drivers for an adopter's interest. In our study the respondents had a technical potential for biogas, and they discussed the attributes of biogas use in a very positive manner, showing appreciation and preference for biogas use. However, they also made passive comments regarding the lack of information and exhibited a lack of interest to visit biogas users. The observations showed little consistency with the model of Ni and Nyns (1996) as the lack of interest was referred to despite most of the motivation factors being present. One possible explanation is that the misperception of biogas financial implications may outweigh the other motivation factors and deter potential users from being interested in acquiring more information about biogas.

Overall, if such phenomenon of passive behaviour towards obtaining information is proved on a population level, it may hinder the expectations that biogas adoption rate will progressively increase with more adopters in the neighbourhood.

5.4 Options for funds

The challenge of money is often cited in the literature on biogas adoption; likewise, *"lack of money"* was often stated as a reason for biogas non-adoption in our discussions. However, the findings of this study show that the same label may refer to two distinct issues: first, biogas maybe perceived as an expensive option in comparison to other cooking fuels, and thus provoke the complains about money (see above); and second, the cost structure of biogas requires a household to have a lump sum at the time of construction, which is cumbersome given the high cost of biogas digester relative to an average household income. These two issues were showed to have different implications, since the first is a matter of perception and the second is a matter of household abilities to obtain funds. However, in the household surveys of the previous studies the distinction between the two was not addressed (see Mwakaje, 2008; Mwigiri et al., 2009).

Examining the challenge of funds, the tradeoffs between savings and credit were elicited. The results showed no clear preference for credit over savings. Savings were not perceived as a feasible option to accumulate that much of money. On the other hand, credit was not a desired option due to a fear of loosing one's property, while credit accessibility issues were not pronounced as problematic. Though lack of access to credit may be a factor hindering biogas adoption (Gichohi, 2009), the observations of this study indicate that the problem may not be

recognized by households. A more prevalent issue was the perceived credit risks, therefore, facilitation may be needed to tackle household's perceptions of credit and to increase their willingness to use it.

Notably, the perceived inability to save was compromising both options for funds, savings and credit. There was a stated lack of confidence in one's ability to save, due to the many competing needs, unstable income from farming, and lack of determination. Therefore, it was perceived to be almost impossible to accumulate savings over time. For the same reasons, credit was perceived as posing a risk to loose one's property: the inability to save leads to a possibility of failure to pay back the loan and a risk of the collateral.

Though biogas adoption maybe an opportunity to improve a household's potential to save, since the actual household spending decreases, such rationales were not observed in the fieldwork. On the contrary, credit for biogas was perceived to be more risky than credit for business purposes, since biogas does not generate additional income, it only reduces spending. The reduced spending was not perceived as tangible savings, which is linked with the misperceptions of biogas financial effects. Therefore, increasing the understanding of the financial effects of biogas may not only lead to a higher preference for biogas use, but also may increase the confidence in one's ability to save and even pay back the loan. Consequently, the recognized tangible savings from biogas adoption are likely to increase household preference for credit.

Overall, it may be that the cost structure of biogas is single most important deterrent from biogas adoption. First, it does not fit the pattern of relatively low household income and little share of savings, thus, bringing up the issue of funds. Second, its financial effects are not well perceived. To prove the point, the "gas for cash" model was offered as an alternative way of biogas acquisition according to the principle "pay for use". The model generated widely positive feedback, which is showed the potential success of such a model, and just how important the challenge of funds is.

6 Conclusions and recommendations

6.1 Conclusions

Considering the prevalent cooking fuel mix, biogas technology offers many advantages to improve the livelihoods of Kenyan households. However, its dissemination has not picked up since the start of promotion thirty years ago. This study attempted to explore households' perceptions influencing their decisions on biogas adoption, and generated the following conclusions.

First, the perceptions of biogas attributes of use indicate a preference for biogas among non-users. Remarkably, the most recognized biogas benefits were savings, availability and convenience, which coincided with the most important stated criteria for a cooking fuel choice. In addition, non-users did not perceive any challenges of biogas use as deterring or making biogas inferior to other cooking fuels.

Only the perception of biogas costs was ambiguous and potentially hampering the preference for biogas. Non-users exhibited a lack of understanding of the long-term financial effects of biogas use. Subsequently, it was hard for them to account for the savings arising from biogas use when considering biogas costs, which led to the perception of biogas as being expensive. The failure to compare the long-term costs of biogas to the other cooking fuels may deter the households from considering biogas adoption.

Second, the perceived challenges of biogas adoption comprised two prevalent issues: lack of funds and lack of information.

Notably, the stated challenge of *"lack of money"* was linked with two distinct issues: the misperception of biogas cost, and the lack of funds for biogas construction. Addressing the challenge of funds, it was found that non-users did not perceive credit as inaccessible. In stead there was no clear preference for credit over savings due to the associated risks of loosing one's property. Moreover, the lack of confidence in one's ability to save amplified the perceived credit risks. Therefore, improving the understanding of biogas financial effects as generating tangible savings may increase the preference for credit.

The challenge of information was widely pronounced among the participants though the study was carried out mostly in the locations with biogas users. It was observed that the presence of biogas users may not increase the exposure of surrounding households to the technology. Moreover, an issue of lack of interest emerged as a possible reason for the observed household passiveness with respect to obtaining more information about biogas. Again the misperception of biogas cost could be a reason for the demonstrated lack of interest.

Overall, the cost structure of biogas appears to be influencing all the issues brought up. The perception of the financial effects of biogas may be decisive to the preference for biogas use. Consequently, the preference for biogas use determines the interest in biogas that is crucial to acquire more information about the technology and actually consider the option to adopt it. Finally, the recognition of the savings arising from biogas use can increase the trust in one's ability to save and the willingness to take credit.

6.2 Recommendations for biogas promotion

Stemming from the findings of this study the following recommendations for biogas promotion in Kenya could be made. First, there are a few attributes of biogas use that could be promoted more to increase households' preference for biogas:

- First, it is important to promote a framework allowing for non-users to evaluate biogas costs in comparison to other fuels, since the exhibited misperception of biogas financial effects may be the single, but most important deterrent of biogas use.
- Biogas promotion should focus on the aspects of cost, availability and convenience, since these are the most important criteria considered by households when choosing a cooking fuel.
- Another point for biogas promotion is the financially unrestricted use of cooking energy once biogas is adopted. It would increase a household's financial energy security since the household would not be dependent on the price fluctuations of other cooking fuels. This aspect should be important to households given their high spending on cooking energy.
- Bio-fertilizer should be promoted more among potential users, since its effects are supported by literature and user experience, while there was an ambiguous opinion about its added value observed among non-users.
- Finally, household awareness of the positive biogas affects on health should be promoted. Though currently health is stated to be a minor criterion for cooking fuel choice, there are estimates showing the high costs incurred by households due to indoor pollution (Pant, 2007). If households came to realize these costs, there would be more reasons to opt for biogas.

Moreover, the findings suggest that biogas promotion should be targeted at two stages: generating an interest in biogas among non-users and increasing the opportunities to obtain detailed information for those interested. Therefore, information through media, like radio or newspapers, or books can be a cost-efficient way to reach many households and effective enough to generate an interest on a wider scale. Structured comparisons of biogas and other cooking fuels based on their attributes of use and cost implications over time may provide useful insights to households and help to realize the advantages of biogas. The generated interest could bring more initiatives from households to obtain practical information themselves: like visiting biogas users or contacting biogas contractors. Since an actual visit to see a biogas digester was observed to be decisive for an adoption, biogas users should be motivated to be open to visitors and expose their experience, which agrees to the recommendations in previous studies (Mwigiri et al., 2009; Walekhwa et al., 2009)

Finally, the options to supply households with biogas at a cost structure adjusted to their income patterns could be explored in practice. The tested "gas for cash" model generated very positive feedback and a high interest among non-users, suggesting the potential of such a supply model.

6.3 Recommendations for further research

There are a number of topics which could benefit from further research:

- Though this study inferred a preference for biogas use from qualitative discussions, a structured comparison of available cooking fuel options based on a set of criteria could enrich the understanding on the rationales of household fuel choice.
- The understanding of the financial effects accruing over time deserves further research since it may be the underlying factor of many challenges to biogas adoption. The level of understanding of the framework could be tested using choice modelling and more in depth qualitative discussions.
- The lack on interest to pursue available information was an unexpected outcome in this study; therefore, further studies on the prevalence of the phenomenon and the reasons for it could yield valuable insights.
- Also it should be researched what kind of information is lacking for the households, as the claim is often cited without underlying explanations.

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Annex A FGD facilitator guidelines

Introduction

- This research is about on households' opinions about biogas as a fuel for cooking, its challenges and benefits and how it compares to other fuels.
- Our discussion will last for about 1.5 hours. We will offer some refreshments at the end of the discussion.
- We are not promoting biogas; therefore different opinions about it are welcome. Feel free to have your own opinion which may not agree with the group.

Technology & information sources

1. How did you get to know about biogas technology? (for the first time, etc.)
2. Imagine you have to describe biogas as a cooking fuel to someone who does not know anything about it. How would you do it? How biogas works? How can it be used in your house?
3. What inputs can you use to feed biogas digester? What about latrine?
4. How would you decide on the size of the biogas plant?
5. If you wanted to know more details about biogas technology (how it works, how to get it), where could you get information from? What organizations/ how many contractor do you know related to biogas?
6. How would you describe people who already have a biogas digester?

Benefits of biogas use

1. Why could biogas be attractive as a cooking fuel?
2. Who from the household benefits most from the use of biogas? How?

In case some of the commonly known biogas benefits are not mentioned, the facilitator neutrally offers them for the group discussion.

Checklist of benefits:

- *savings on cooking fuel costs*
- *fertilizer substitute*
- *time savings*
- *improved health conditions*
- *improved sanitation*
- *deforestation, environmental issues*

Challenges of biogas adoption and use

1. What are the main reasons you have not bought a biogas digester until now?
2. What inconveniences does a household deal with when using a biogas digester?

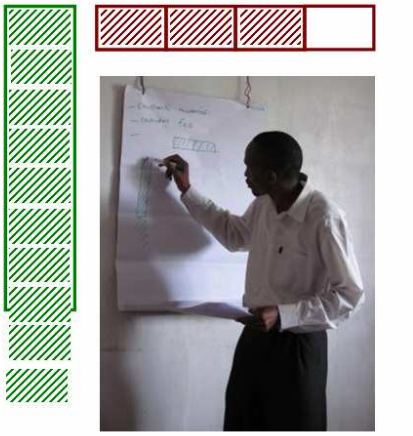
Checklist for challenges of biogas use:

- *additional work*
- *maintenance*
- *technical complexity*
- *ambient effects: smell, aesthetics*
- *cultural taboos*

3. What does it require to keep the digester running without problems?

4. Have you heard of any failures of biogas digesters? What are the reasons for biogas digester failures?
5. What do you think about the service and knowledge of biogas contractors?

Financial effects of biogas use



Facilitator draws a figure representing costs, and then colours it year by year explaining how savings accumulate:
- charcoal example (red object)
- biogas example (green object)

1. What are the costs that a household incurs when obtaining a biogas digester?
2. What are the financial savings once a biogas digester is in use?
   Going through the list of benefits: Are there some benefits of biogas that have no monetary value? (health, sanitation, time) Is it worth taking into account their value?
3. How long do you think it takes for the savings to cover the investment costs? (payback period)
4. Considering biogas average costs (for investment and use), do you think biogas is an expensive fuel? (you would spend all this money over the time anyway, and keep on spending) Do you think it is financially worthwhile to obtain biogas?

Funds for biogas adoption

Obtaining a biogas digester involves high start-up costs.

1. How can a household obtain the necessary funds?
2. What could be the sources of credit? (bank, cooperative, informal sources)
3. What are the conditions you could get credit with? (if group knows) How accessible are sources of credit?

Facilitator adds the additional costs to the drawing and explains the trade-off of getting money now and waiting to save.

4. If would were decided to get biogas, which would you prefer: taking a credit to finance a biogas installation or waiting and accumulating savings? Why? (pros & cons)

"Gas for cash" model

There could be another way to obtain a biogas digester, without any investment costs. A contractor would come and build a biogas digester for your household on his own costs, and you would not pay any money for it. When the installation is complete, you would pay for the gas you use, like you now pay for charcoal. If the digester breaks down, the contractor would fix it for you free of charge. After several years you would own the digester.

1. Would such an offer be attractive for you? Why?
2. Who should be responsible for feeding the digester? Why?
3. Would you rather pay higher price for a certain period or much lower price without an end?
4. For how long do you think it would be fair for a household to pay?
5. What other conditions would be important for you in such an offer?

Thank you for your participation!

Annex B FGD participant questionnaire

Location: ……. Date: ……..

1. Affiliation with biogas

a. Have you heard that it is possible to use biogas as a cooking fuel? YES NO

……

b. Do you know someone using a biogas installation? YES NO

c. Have you seen a biogas installation yourself? YES NO

If yes, when & where? ……

d. **What** and **how many** cattle are there in your household? ……

e. What is the style of farming:

1) free-range 2) zero-grazing 3) mixed ……

If the answers to the first questions indicate that the respondent is familiar with biogas technology and qualifies as a potential customer, he is invited to a FGD. Points to mention:

- We do not offer any financial compensation, but there will be some refreshments provided.
- It will not take more than 1.5 hours. Time & place: … .

2. Participant information

a. Name: ……..……

b. Occupation: ……..……

c. Education: ……. (no. of years):

1) primary 2) secondary 3) post-secondary 4) other ……

d. Age: ……

e. Relation to household head (if participant is not household head): …….

3. Household information

a. Number of household members, who share the same cooked meal: ……

b. Age of the household head (if participant is not household head): ……..……

c. Main household income source (type of farming):……

d. Yearly household income (including subsistence expenditure):

i) <100,000 KSh ii)100,000-200,000 KSh iii) 200,000-300,000 KSh

iv) 300,000-400,000 KSh v) 400,000-500,000 KSh vi) > 500,000 KSh

e. Fuels used for cooking: ……

f. Yearly expenses on fuels for cooking: ……..

4. Attitude towards biogas

a. What is your personal opinion about biogas as a cooking fuel? ……..……

b. Mobile number (optional): ……..……

to inform if any changes occur. We provide our mobile numbers.

Annex C User interview questionnaire

Location: ……. Date: ……..

This research is about on households' opinions about biogas as a fuel for cooking. Our discussion will take about 45 minutes. We do not offer any financial compensation for your contribution.

1) Participant information

c. Name: …… Age: ……

d. Occupation: ……..……..

e. Education: ……. (no. of years):

1) primary 2) secondary 3) post-secondary 4) other ……

f. Relation to household head (if participant is not household head): ……..……

5. Household information

a. Number of household members, who share the same cooked meal: ……..

b. Age of the household head (if participant is not household head): ……

c. Main household income source (type of farming):……..……..

d. **What** and **how many** cattle are there in your household?

……..……

e. What is the style of farming: 1) free-range 2) zero-grazing 3) mixed ……

f. Yearly household income (including subsistence products):

i) <100,000 KSh ii)100,000-200,000 KSh iii) 200,000-300,000 KSh

iv) 300,000-400,000 KSh v) 400,000-500,000 KSh vi) > 500,000 KSh

6. Existent Biogas installation

a. Type……. Size ……For how long do you have it?…….……

b. What inputs do you feed to your biogas digester?

……..…….……

Is the latrine connected? ……..……If not, why?…….……..……

What do you use produced biogas for?

……

Is it sufficient for you family needs?

……

When constructing your digester, how did you decide on the appropriate size of it?

……

c. Cooking fuels in use (indicate proportions):
   before adopting biogas: ……..…
   now (after adopting biogas):……...……
d. Yearly expenses on cooking fuels:
   before adopting biogas: ……..……
   now (after adopting biogas):……

Biogas as a fuel for cooking

7. Information channels & learning

a. How did you get to know about biogas technology? (e.g. for the first time) When you got interested, what sources of information did you use to learn the details how biogas installation should be designed and function?
b. What organizations do you know that are related to biogas? How many contractors are active in your area?
c. What was the reaction of your community when you started using biogas?
   What questions or concerns did visiting people have

8. Benefits

a. Why did you decide to use biogas as a cooking fuel? What were your **expectations**?
b. How did the routines of your household change since you started using biogas? **Who** from the household was most affected by use of biogas? How?
c. What other benefits have you **actually experienced** when using biogas for cooking?

In case some of the commonly known biogas benefits are not mentioned, the interviewer asks about their relevance:

Checklist of benefits:

- *savings on cooking fuel costs*
- *fertilizer substitute*
- *time savings*
- *improved health conditions*
- *improved sanitation*
- *deforestation, environmental issues*

9. Challenges

a. When **obtaining** a biogas digester, what were the major challenges/ difficulties you faced?
b. What does it require to keep the digester running without problems? How difficult or easy is it?

c. What other inconveniences do you face when using a biogas digester?

Checklist for challenges:

- *additional work*
- *maintenance*
- *technical complexity*
- *ambient effects: smell, taste*
- *cultural taboos*

10. Technology and Contractors

a. Have you had any problems with your digester so far? YES NO
If yes, what kind of problems?

b. How do (would) you solve maintenance problems, if they arise?

c. What are the common reasons for biogas digester failures that you know?

d. What has your biogas contractor done to make sure you are satisfied with using biogas?
How were you instructed to use the digester? Any guarantee? Follow-ups?

e. Are you still in contact with the contractor who built your digester? YES NO
If yes, what services do you receive now?

f. What is your opinion about the service and knowledge of biogas contractors?

11. Financial Effects

a. What costs has your household incurred when obtaining a biogas digester? What did you pay for? What are the costs to maintain you biogas digester (if any)?

b. What are the savings for your households once a biogas digester is in use?
Are there some benefits of biogas that have no monetary value? (health, sanitation, time)
Is it worth taking into account their value?

c. How long do you think it takes to recover your investment?

d. From financial perspective, are you satisfied with your decision to adopt biogas? Why?

12. Funds

a. Biogas installation comes with high initial costs. What was your way to obtain the needed funds?
   i. If savings were used: How much time did it take you to save the needed amount for this investment?
   ii. If credit was used: What were the conditions that you took your credit? (accessibility, interest rate, loan period, collateral

b. What other ways to obtain the funds were available for you (if any)? What about informal sources?

c. Why did you choose your source of funds and not any other? credit with extra costs vs. waiting & saving

13. "Gas for Cash" model

Imagine there could be another way to obtain a biogas digester, without any investment costs. A contractor would come and build a biogas digester for your household on his own costs, and you would not pay any money for it. When the installation is complete, you would pay for the gas you use, like you now pay for charcoal. If the digester breaks down, the contractor would fix it for you free of charge. After several years you would own the digester.

a. Would such an offer be attractive for you, if you had not had a biogas digester yet? Why?
b. Who should be responsible for feeding the digester? Why?
c. Would you rather pay higher price for a certain period or much lower price without an end?
d. For how long do you think it would be fair for you to pay for the gas?
e. What other offer conditions would be important for you, as a client?

Thank you for your participation!

Annex D Respondents data

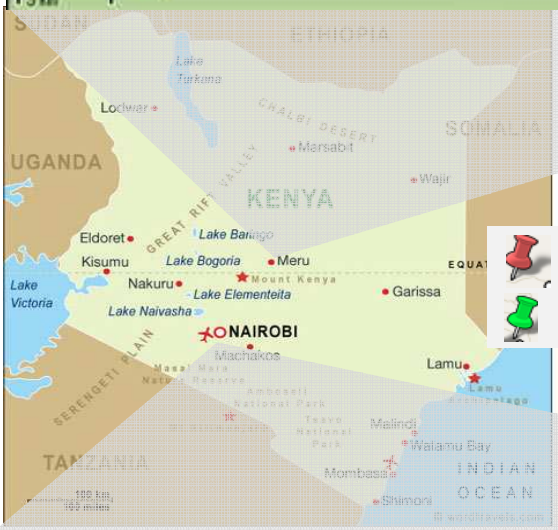
Area	Focus Group	Biogas users around	Group size	Age			Education*		Occup.	HH size	Income level*		Main cooking fuel*		Yearly expenses on cooking fuel			Knows a user	Seen biogas
				Min	Av	Max	Type	%	Farmers		Range	%	Type	%	Min	Av	Max	%	%
Nairobi	Ruku Men	YES	6	24	40	67	secondary	67%	83%	4	< 200	100%	charcoal	83%	10.800	19.733	28.800	100%	67%
	Ruku Women		11	24	38	49	secondary	73%	64%	4	100-200	73%	charcoal	64%	12.000	24.346	48.000	100%	55%
	Kerarapon Men		9	20	34	50	secondary	56%	44%	5	100-200	56%	firewood, gas	89%	7.200	19.200	36.000	56%	44%
	Kerarapon Women		9	32	41	55	secondary	67%	67%	5	100-400	78%	charcoal, firewood	78%	9.600	30.633	72.000	100%	44%
	Kabete Men	NO	7	25	35	58	secondary, higher	71%	14%	5	< 200	71%	firewood, gas	71%	9.600	33.943	78.000	14%	57%
	Kabete Women		11	19	36	70	secondary, post-secondary	73%	82%	5	< 100	73%	charcoal, firewood	64%	3.600	23.891	72.000	36%	45%
Peri-urban Nairobi area					**37**				**59%**	**4,82**	**< 200**	**77%**				**25.291**		**68%**	**52%**
Meru	Kithirune Men	YES	6	30	49	66	secondary	83%	100%	4	< 200	83%	firewood	100%	0	8.500	36.000	83%	67%
	Kithirune Women		6	33	46	62	primary, secondary	83%	83%	4	100-200	83%	firewood	100%	0	17.580	38.280	100%	33%
	Timau Men		7	25	43	55	secondary	71%	86%	5	100-200	57%	firewood	100%	0	18.786	60.000	86%	43%
	Timau Women		7	31	44	61	secondary	71%	86%	5	< 200	71%	firewood	100%	12.000	25.714	52.000	100%	86%
	Kianthumbi Men	NO	8	36	47	62	secondary	50%	75%	5	< 200	100%	firewood	100%	0	13.475	36.000	38%	50%
	Kianthumbi Women		8	27	41	60	secondary	63%	88%	4	< 200	63%	firewood	88%	6.000	13.988	28.400	25%	38%
Interior Meru area					**45**				**86%**	**4,61**	**< 200**	**79%**				**16.340**		**72%**	**53%**
Total			**95**	**19**	**41**	**70**	**secondary**	**59%**	**72%**	**5**	**< 200**	**78%**	**firewood**	**63%**	**0**	**21.260**	**78.000**	**68%**	**52%**

Area	Location	Gender	User	Age	Education	Occupation	HH relation	HH size	Income level	Main Cooking fuel now	Main cooking fuel before	Yearly exp. on cooking, before	Duration of ownership	Subsidy
Nairobi	Ruku	Woman	User A	51	secondary	farmer	wife	5	>500	Biogas	gas	55.400	12	YES
	Ruku	Man	User B	55	post-secondary	farmer & teacher	head	7	>500	Biogas	gas	60.000	60	YES, later
	Kerarapon	Woman	User C	33	university	teacher	wife	4	200-300	Biogas	gas	36.000	12	YES
	Kerarapon/ Bulbul	Women	User D	54	university	government official	wife	6	>500	Biogas	gas	80.400	24	YES
Peri-urban Nairobi area				**48**				**5,5**		**Biogas**	**Gas**	**57.950**		
Meru	Kithirune	Man	User E	38	secondary	farmer	head	4	<100	Biogas	charcoal	60.000	7	YES
	Kithirune	Man	User F	41	post-secondary	farmer	head	6	> 500	Biogas	firewood	36.000	11	NO
	Kithirune/ Nthimbiri	Man	User G	50	secondary	business & farming	wife	3	200-300	Biogas	gas	18.000	0,5	YES, later
	Kithirune/ Nthimbiri	Woman	User H	52	post-secondary	teacher	wife	5	200-300	Biogas	firewood	27.600	7	NO
	Timau	Man	User J	65	post-secondary	farmer, retired teacher	head	4	100-200	biogas	firewood	4.000	24	NO
Interior Meru area				**49**				**4,4**		**Biogas**	**Firewood**	**57.950**		

* For the indicated respondent data the most dominant characteristics in a group are presented. A percentage indicates a share of group members who have the characteristics specified. At least 50%of group members are described by provided characteristics. For example: the range of income for each group is selected so that it comprises at least 50% of group participants.

Annex E Fieldwork locations

INTERIOR MERU AREA



- No users of biogas around

- There are users of biogas around

Interior Meru area
1 – Timau
2 – Kianthumbi
3 – Kithirune

Peri-urban Nairobi area
4 – Kerarapon
5 – Ruku
6 – Kabete

PERI-URBAN NAIROBI AREA